MODEL 122
PULSE GENERATOR

Serial # A-375446

E-H RESEARCH LABORATORIES, INC.
163 ADELINE STREET · OAKLAND, CALIFORNIA 94607

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PULSE GENERATOR

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FOREWORD

Units, abbreviations and prefixes of the International System of Units (SI) are used in this manual. Discrepancies may be noted between the terms used in the text and the instrument panel markings (e. g. ; hertz, kilohertz, megahertz for cps, kilocycles, megacycles, etc.)

The National Bureau of Standards announced its approval of the SI in February 1964, and subsequently the document was adopted by Congress as a national standard.

TABLE OF CONTENTS

SECTION 1 CHARACTERISTICS

1-1	General	1-1
1-2	Specifications	1-1
1-3	Accessories	1-2
1-4	Applications	1-2

SECTION 2 OPERATING INFORMATION

2-1	Unpacking	2-1
2-2	234 Volt Operation	2-1
2-3	Output Impedance	2-1
2-4	Cables, Connectors, and Attenuators	2-1
2-5	Operating Controls and Connectors	2-1
2-6	Operating Notes	2-1

SECTION 3 THEORY OF OPERATION

3-1	General	3-1
3-2	Block Diagram	3-1
3-3	Master Schematic	3-1
3-4	Timing Circuit Board Schematic	3-1
3-5	Output Circuit Board Schematic	3-6
3-6	Attenuator Schematic	3-8
3-7	Power Supply Schematic	3-8

SECTION 4 MAINTENANCE

4-1	General	4-1
4-2	Routine Maintenance	4-1
4-3	Performance Verification	4-1
4-4	Trouble - Shooting	4-4

SECTION 5 PARTS LIST

5-1	Ordering Information	5-1
5-2	Warranty	5-1
5-3	Timing Circuit Board	5-2
5-4	Output Circuit Board	5-3
5-5	Power Supply	5-3
5-6	Chassis and Panel Components	5-4

SECTION 6 DRAWINGS

APPENDIX SUMMARY... PULSE GENERATORS

E-H PULSE ACCESSORIES

LIST OF ILLUSTRATIONS

SECTION 1 CHARACTERISTICS

Figure 1-1 Model 122 Pulse Generator 1-0
Figure 1-2 Gated Output-Pulse Waveforms 1-2
(10 ns/cm, 500 mv/cm; gating signal at 400 mv/cm)

SECTION 2 OPERATING INFORMATION

Figure 2-1 Duty Factor vs Output Pulse Polarity 2-2
Figure 2-2 Output Pulse Baseline Offset 2-2

Table 2-1 Operating Controls and Connectors 2-3

SECTION 3 THEORY OF OPERATION

Figure 3-1 Model 122 Block Diagram 3-2
Figure 3-2 Timing Circuit Block Diagram 3-4
Figure 3-3 Output Circuit Block Diagram 3-7

SECTION 4 MAINTENANCE

Table 4-1 Power Supply Voltages 4-6

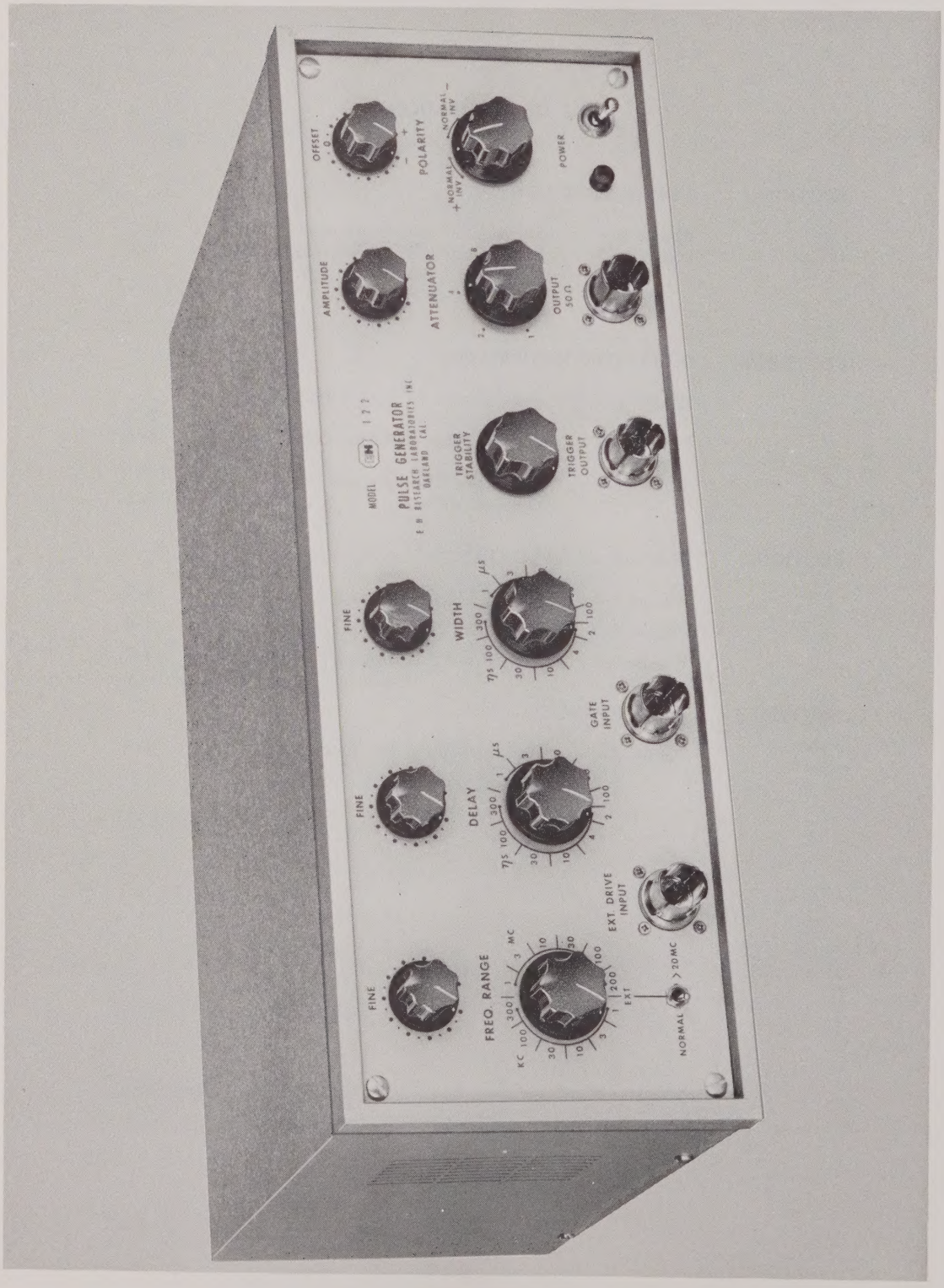


Figure 1-1 Model 122 Pulse Generator

SECTION 1
CHARACTERISTICS

1-1 GENERAL

The E-H Model 122 is a solid-state pulse generator that provides fast risetime, fast falltime pulses at high pulse repetition rates. Pulse repetition rate is variable from 1 kilohertz to 200 megahertz with variable pulse width, delay, and output levels. Output pulse risetime and falltime is one nanosecond or less.

Duty factor capability is better than 40%; also, output pulse waveforms may be inverted to provide an equivalent duty factor of 90% or higher. The baseline offset feature allows the pulse train to be adjusted off the zero reference, up to one volt, in either polarity.

A separate trigger output provides signals for triggering oscilloscopes, additional pulse generators or other test instruments. Model 122 may be driven by another pulse generator at any repetition rate from 1 kilohertz to 100 megahertz. The Model 122 output pulse train can be gated by an externally supplied pulse or dc control signal. The instrument is packaged within a durable, heavy-duty metal frame suitable for either rack or cabinet mounting.

1-2 SPECIFICATIONS

REPETITION RATE: 1 kilohertz to 200 megahertz from internal clock. 1 kilohertz to 100 megahertz external clock. Repetition rate is continuously variable from 1 kilohertz to 200 megahertz by a coarse selector (1/3/10/30/100/300 kilohertz, 1/3/10/30/100/200 megahertz), and a vernier control.

RISE AND FALLTIMES (10% to 90%): 1 nanosecond or less at rated amplitude. Risetime and falltime decrease as pulse amplitude is reduced.

WIDTH: 2 nanoseconds to 100 microseconds, continuously variable by coarse selector (2/4/10/30/100/300 nanoseconds, 1/3/10/30/100 microseconds), and a vernier control.

DELAY: 2 nanoseconds to 100 microseconds, continuously variable by coarse selector (2/4/10/30/100/300 nanoseconds, 1/3/10/30/100 microseconds), and a vernier control.

AMPLITUDE: Adjustable, ± 5 volts to ± 150 millivolts, by coarse attenuator, with ranges of 1:1, 2:1, 4:1, 8:1, and 16:1, and a 2:1 vernier control.

OUTPUT TERMINATING IMPEDANCE: 50 ohms. E-H Model 122 operates as a dc coupled current source. The output impedance is approximately 50 ohms at high frequencies, in the 1:1 attenuator position. The output is short and open-circuit protected, but is not intended for operation in the open-circuit condition for extended periods.

DUTY FACTOR: 40% or less for normal output polarities. Neither delay time nor width time should exceed 40% of the pulse period. In addition, an inverting logic feature provides the equivalent duty factor of 90% or higher, except as limited by minimum pulse width (2 nanoseconds).

BASELINE OFFSET: ± 1 volt minimum, adjustable either polarity. Output pulses may be inverted so the baseline is at either +5 or -5 volts (depending on amplitude setting); in this condition, the pulse reference level is also adjustable ± 1 volt.

WAVEFORM: Pulse top or baseline distortion less than 5% peak-to-peak.

JITTER: Less than 0.1%, + 50 picoseconds including repetition rate, width, and delay jitter.

EXTERNAL DRIVE INPUT: +1.5 volts (optimum) pulse; input impedance is 50 ohms. Another pulse generator is recommended for external drive since the higher average power in sinewave type driving signals may damage the external drive circuitry. For best results, the external drive signal should have a fast risetime; 1 nanosecond/volt is preferable. When the External Drive Mode switch is set in the >20 MHz position, output pulse width plus delay time must not exceed the external drive pulse width.

TRIGGER OUTPUT: +0.25 volts into 50 ohms. An internal countdown circuit provides increased oscilloscope trigger stability. For internal frequencies above the 3 megahertz range, the trigger output counts down to approximately 3 megahertz.

GATE INPUT: -1 volt (optimum) pulse or equivalent dc level is required to block the pulse train.

DIMENSIONS:

Cabinet-mount:	6" high, 17" wide, 12" deep
Rack-mount	7" high, 19" wide, 12" deep
Weight:	27 lbs net.

POWER REQUIREMENTS: 105 to 125 vac, 50/60 Hz, 120 volt-amperes (ready conversion to 234 volt service is a standard feature on the Model 122).

1-3 ACCESSORIES

E-H Model 901 MARKER GENERATOR. This accessory unit contains passive circuits and provides 1 nanosecond markers for time-base calibration.

E-H Model 971 RISETIME STANDARD. The risetime standard produces fixed, repeatable risetimes from fast pulse inputs. Standard times are 5.0, 2.0, 1.0, 0.5, and 0.2 nanoseconds.

E-H Model 902 TUNNEL DIODE PULSER. Produces 450 millivolt pulses, with less than 100 picosecond risetime, from waveforms applied to input (-1 volt minimum input required). It may be used to drive the E-H Model 971.

E-H Model 960 TAP-OFF. This accessory is a 50-ohm transmission line sampling device; it has a 100:1 pick-off ratio.

ADDITIONAL ACCESSORIES. The E-H Model 122 input and output connectors are compatible with all standard E-H pulse accessories equipped with General Radio 874 series connectors. For more details, refer to the E-H Pulse Accessory information in the back of this manual.

1-4 APPLICATIONS

High repetition rates and fast rise-fall times make E-H Model 122 suitable for the development and testing of oscilloscopes, radar systems, digital computer systems, telemetry systems, digital logic and counter response, and other similar uses. Model 122 may be used in conjunction with various E-H clock-pulse generators, delay and gate-pulse generators, delay and drive generators, current sources, or accessories to produce serial pulse trains or pulse-code signals for systems work.

Model 122 may be used in time-domain component testing, where a known excitation function is applied to the device under test and the response function is analyzed to give the desired information. Thus, specific parameters of the device under test may be measured, including switching times, reflections due to discontinuity or mismatch, and other characteristics.

An oscilloscope is often used in conjunction with the Model 122 for display and measurement of signal waveforms, portions of pulse trains, aperiodic events, and non-recurrent events. For precise measurements, the risetime of the display oscilloscope should be less than one-fifth of the risetime of the input signal. With faster risetime capability, good sweep timing and linearity, and good vertical linearity, oscilloscope measurement errors can be minimized.

An adjustable, internal delay between the trigger pulse and the output signal is incorporated for advance triggering or synchronization of other test instruments, such as pulse generators or oscilloscopes. The delay time should be somewhat greater than the time taken by the oscilloscope sweep-generator to initiate the sweep. Allow sufficient delay where appreciable time is required for the CRT beam to turn on or for the oscilloscope sweep to become linear. When triggering other pulse generators, the specific application will determine the delay time. The wide range of delay times, pulse widths, output levels, and pulse repetition rates available in the Model 122, ensures the maximum flexibility for most applications.

For more information concerning applications, pulse definitions, and pulse generating circuits, consult the E-H booklet entitled "Pulse Generators".

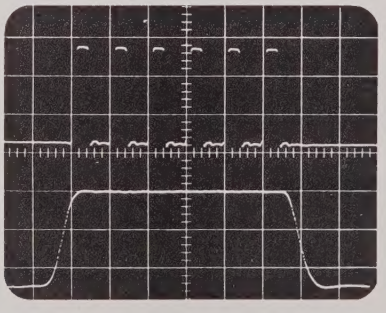


Figure 1-2 Gated Output-Pulse Waveforms (10 ns/cm, 500 mv/cm; gating signal at 400 mv/cm.)

SECTION 2
OPERATING INFORMATION

2-1 UNPACKING

Immediately after unpacking the instrument, carefully inspect and evaluate the condition of the shipping container and instrument for evidence of damage that might have occurred during shipment or handling. If damage is noted, the responsible carrier or agency should be promptly notified. Operation of the instrument may be checked by utilizing the procedures given in SECTION 4-3, PERFORMANCE VERIFICATION.

2-2 234 VOLT OPERATION

The internal power supply of the E-H Model 122 is normally wired for 117 vac operation. For 234-volt operation, reconnect the transformer primary. Refer to the Power Supply Schematic for the proper connections.

2-3 OUTPUT IMPEDANCE

The Model 122 is designed to operate into a 50-ohm, pure resistive load. Operation into any other impedance will cause some pulse distortion. Loads with appreciable capacitive or inductive components will have a marked effect on the leading and falling edges of the pulse.

Use the E-H Model 975 Sequential Transformer to match the Model 122 output to 1-ohm loads. For additional accessory information, refer to the E-H Pulse Accessory information in the back of this manual.

NOTE

For best waveform fidelity, the Model 122 terminating impedance should always be as close to 50 ohms as possible.

2-4 CABLES, CONNECTORS AND ATTENUATORS

The sharp risetime of the Model 122 has appreciable frequency components up to 1 gigahertz. If any of these high frequency components are attenuated through the use of connectors, cables, or attenuators that do not have a flat frequency response in excess of these frequencies, degradation of the pulse rise-time will result. Mismatch effects can also degrade the pulse waveform; consequently, consideration and care must be taken to preserve the quality of the pulse output when coupling it to the system or device under test.

Some of the precautions to observe in coupling the pulse outputs of this instrument are:

a. Always terminate the output of the Model 122 in a 50-ohm, pure resistive load.

b. If the input impedance of the device or system under test is other than 50 ohms, use an impedance matching device so that mismatch effects will not degrade the pulse waveform.

c. Make sure that all connectors, attenuators, and cables are of proper impedance and have a flat frequency response in excess of 1 gigahertz. Use only high-quality 50-ohm coaxial cable, such as RG213/U. For best results, use short cables, since long cables tend to attenuate the high frequency components of the pulse. General Radio (GR) 874 series coaxial connectors are recommended for use with the Model 122.

2-5 OPERATING CONTROLS AND CONNECTORS

Table 2-1 contains a list of operating controls, along with the function of each.

2-6 OPERATING NOTES

a. OUTPUT PULSE DROPOUT. At pulse repetition rates above 100 megahertz, the Model 122 OUTPUT pulse train may occasionally disappear when changing the polarity or repetition rate controls, but can be regained by readjusting the FINE (WIDTH) control.

b. EXTERNAL DRIVE MODE OPERATION. For external drive operation at repetition rates greater than 20 megahertz, set the External Drive Mode (NORMAL, >20 MHz) toggle switch to the

>20 MHz position. The sum of the output pulse width plus delay time must be less than the external drive pulse width; thus, the DELAY and WIDTH controls must be properly set during external drive operation above 20 megahertz. At pulse repetition rates lower than 20 megahertz and with the External Drive Mode switch set to NORMAL, the output pulse width and delay are independent of the external-drive input pulse.

c. DUTY FACTOR CONSIDERATIONS. Normal duty factor limitation on the Model 122 is 40% (neither delay time nor width time should exceed 40% of the pulse period). To obtain duty factors greater than 40%, output pulse polarity must be inverted. (See Figure 2-1.)

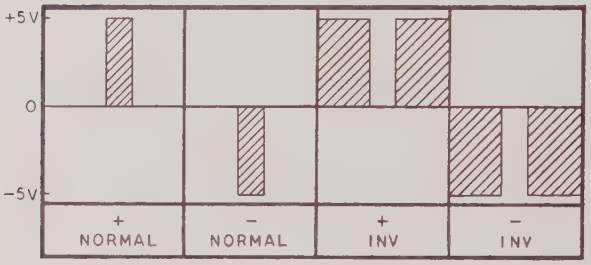


Figure 2-1 Duty Factor vs Output Pulse Polarity

With inverted pulses, the main duty factor limitation is that of the minimum pulse width, which is 2 nanoseconds. Thus, if output-pulse period is 5 nanoseconds (200 megahertz), and minimum pulse width is 2 nanoseconds, the maximum duty factor is 60 per cent. If the pulse width remains constant, but the period is increased (frequency is decreased) the effective duty factor will increase.

d. OFFSET OPERATION. The OFFSET control, located above the POLARITY selector switch, provides a baseline offset of ± 1 volt. Offset is provided, regardless of pulse polarity or amplitude.

The offset operates by summing currents from a fixed positive source and a variable negative source. The negative current is variable from zero to -40 milliamperes. The positive source supplies +20 milliamperes more than required for pulse operation. For +1 volt offset, the negative source provides zero current; for -1 volt offset, it provides -40 milliamperes.

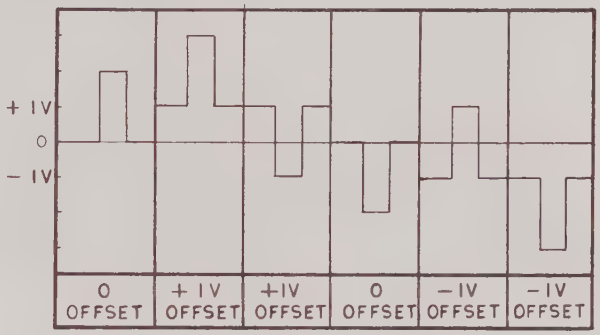


Figure 2-2 Output Pulse Baseline Offset

e. GATE INPUT OPERATION. The gate circuit disables the clock circuit for the duration of the GATE INPUT signal. If the gate signal is repetitive, the output signal of the Model 122 will be a series of pulse bursts. The bursts are separated in time by the gate pulse width. The duration of each burst is determined by the time the gate signal is off. The frequency of the pulse bursts is determined by the gate pulse period.

For example, suppose the desired pulse burst is to recur every 100 nanoseconds. There are to be five pulses in each burst, and each pulse in the burst is to recur every 10 nanoseconds. For these conditions, adjust the gate pulse generator for a 10 megahertz repetition rate (gate pulse period = 100 nanoseconds). For 10 nanosecond pulses in each burst, the clock multivibrator should remain on longer than 45 nanoseconds, but less than 55 nanoseconds. Therefore, the gate pulse width should be somewhat greater than 45 nanoseconds, but less than 55 nanoseconds (gate pulse duty factor ≅ 50%). For 10 nanosecond pulse repetition period on the Model 122, adjust the internal clock to 100 megahertz (pulse period = 10 nanoseconds).

TABLE 2-1 OPERATING CONTROLS AND CONNECTORS

ITEM	FUNCTION
POWER	With the line cord connected to a 117 vac 50/60 Hz power source, turn the POWER switch to the ON position; the fan will start and the POWER indicator will light.
FREQ. RANGE	Selects pulse repetition rate as determined by either an external drive input or internal clock. Pulse repetition ranges are: 1/3/10/30/100/300 kilohertz; 1/3/10/30/100/200 megahertz; or external drive of 1 kilohertz to 100 megahertz.
FINE (FREQ. RANGE)	Continuously variable; adjusts pulse repetition rate in a given range, with overlap to adjacent ranges.
DELAY	Selects time delay between TRIGGER OUTPUT pulse and OUTPUT 50Ω pulse. Delay-time ranges are: 2/4/10/30/100/300 nanoseconds; and 1/3/10/30/100 microseconds.
FINE (DELAY)	Continuously variable; adjusts pulse delay time in a given range, with overlap to adjacent ranges.
WIDTH	Selects pulse width over a range from 2 nanoseconds to 100 microseconds. Pulse width ranges are: 2/4/10/30/100/300 nanoseconds; and 1/3/10/30/100 microseconds.
FINE (WIDTH)	Continuously variable; adjusts pulse width time in a given range, with overlap to adjacent ranges.
TRIGGER STABILITY	Adjusts the TRIGGER OUTPUT circuit for stable operation. At pulse repetition rates above (approximately) 3 megahertz, the trigger circuit counts down to about 3 megahertz. At pulse repetition rates below (approximately) 3 megahertz, the TRIGGER STABILITY control is adjusted so that the TRIGGER OUTPUT provides one pulse for every output pulse .
ATTENUATOR	Provides 5 resistive step attenuation ratios. With the OUTPUT 50Ω connector terminated by a 50-ohm resistive load, the attenuation steps are: 1:1, 2:1, 4:1, 8:1 and 16:1. The ATTENUATOR, in conjunction with the AMPLITUDE control, provides pulse amplitudes over the range of ± 5 volts to ±150 millivolts.
AMPLITUDE	Continuously variable; adjusts OUTPUT 50Ω pulse amplitude while operating in conjunction with the ATTENUATOR selector switch.
POLARITY	Selects one of four OUTPUT 50Ω pulse modes: +NORMAL, +INV., -NORMAL, and -INV. See SECTION 2-6 c, DUTY FACTOR CONSIDERATIONS, Figure 2-1.
OFFSET	Adjusts OUTPUT 50Ω pulse baseline voltage level, permitting continuous baseline offset adjustment between +1 volt and -1 volt, regardless of pulse polarity and amplitude. See SECTION 2-6 d, OFFSET OPERATION, Figure 2-2.
EXT. DRIVE MODE NORMAL, >20MHz (TOGGLE SWITCH)	For best results, the External Drive Mode (NORMAL >20MHz) toggle switch should be set to the NORMAL position for external drive signals less than 20 MHz. It should be in the >20 MHz position for external drive signals greater than 20 MHz.

(Continued)

TABLE 2-1 OPERATING CONTROLS AND CONNECTORS
(CONTINUED)

ITEM	FUNCTION
	In this position, the sum of the delay time plus the pulse width must be less than the external drive pulse width. If the switch is set in the NORMAL position when operating at drive frequencies greater than 20 megahertz, erratic pulsing may occur.
OUTPUT 50Ω CONNECTOR (GR 874 CONNECTOR)	Connects the OUTPUT 50Ω signal to the external load. For best results, use a 50-ohm external load and 50-ohm coaxial cable, such as RG213/U. When the ATTENUATOR selector switch is set to 1, the Model 122 appears to the load as a current source, regardless of output pulse polarity and amplitude.
TRIGGER OUTPUT CONNECTOR	Provides a +0.25 volt pulse into 50 ohms for driving or synchronizing other instruments. At OUTPUT 50Ω pulse repetition rates above (approximately) 3 megahertz, the TRIGGER OUTPUT counts down to about 3 megahertz. At OUTPUT 50Ω pulse repetition rates below (approximately) 3 megahertz, the TRIGGER OUTPUT occurs at the same rate as the output signal. This function operates in conjunction with the TRIGGER STABILITY control.
GATE INPUT CONNECTOR	Application of a -1 volt pulse or an equivalent dc level inhibits the OUTPUT 50Ω pulse train. Removing the gate signal level or returning to zero volts dc level re-enables the pulse output. Pulse trains of up to 100 megahertz may be gated.
EXT. DRIVE INPUT CONNECTOR	At this connector, the E-H Model 122 can be driven by +1.5 volt pulses from another pulse generator at pulse repetition rates from 1 kilohertz to 100 megahertz. This function operates in conjunction with the FREQ. RANGE selector switch and the External Drive Mode (NORMAL > 20 MHz) switch. To operate, turn the FREQ. RANGE selector to EXT., connect the drive signal to the EXT. DRIVE INPUT, and set the External Drive Mode switch.

SECTION 3
THEORY OF OPERATION

3-1 GENERAL

The E-H Model 122 is comprised electrically of chassis-mounted sub-assemblies and components that are discussed, by drawing, in the following order: Block Diagram, Master Schematic, Timing Circuit Board Schematic (Sheets 1 and 2), Output Circuit Board Schematic, Attenuator Schematic, and Power Supply Schematic. Detailed block diagrams are provided in support of the Timing Circuit and Output Circuit Schematic Diagram discussions.

3-2 BLOCK DIAGRAM

(Refer to Figure 3-1.)

As shown in the block diagram, both external GATE INPUT and EXT. DRIVE INPUT signals may be applied to the clock circuit. A negative 1-volt signal to the GATE INPUT (pulse or dc control voltage) inhibits the clock circuit. The EXT. DRIVE INPUT signal (positive 1.5 volt pulses) drives the clock circuit from an external source.

When the External Drive Mode switch is set to NORMAL, the OUTPUT 50Ω signal is independent of the EXT. DRIVE INPUT pulse width. When the External Drive Mode switch is set to >20 MHz, the maximum output pulse delay time plus width should be less than the EXT. DRIVE INPUT pulse width.

FREQ. RANGE and FINE (FREQ. RANGE) front-panel controls adjust the internal clock repetition rate. Output from the clock circuit is connected to the trigger and delay circuits.

The delay circuit provides a delayed start pulse both to the adder and to the width circuits. This effectively provides an adjustable delay between the TRIGGER OUTPUT signal and the OUTPUT 50Ω signal.

The output from the delay circuit initiates pulse-width formation of the OUTPUT 50Ω signal by providing start pulse to the adder circuit and a drive pulse to the width circuit. After the variable width time has ended, the width circuit provides a stop pulse to the adder circuit. The time between the start and stop pulses corresponds to the duration of the adder output, which determines the output pulse width. The adder functions as a two-input bistable circuit that permits extremely fast changes in operating state and output waveform.

The Output Circuit has several current amplifier stages that provide power gain to drive the output current summation circuit. By adding current from three sources, the summation stage provides 5 volt pulses in any of four modes. The output pulses may be either positive or negative, and normal or inverted. Pulse amplitude is adjustable, and baseline offset is variable up to ± 1 volt.

An output attenuator, in conjunction with the amplitude control, provides five switch-selected attenuation ratios of 1:1, 2:1, 4:1, 8:1, and 16:1. Output amplitude is therefore continuously variable from ± 5 volts to 150 millivolts. The pulsed output signal appears at the OUTPUT 50Ω connector. This output appears to the load as a current source when the ATTENUATOR selector is set to 1, and the terminating impedance is 50 ohms.

3-3 MASTER SCHEMATIC

(Refer to Drawing Number D-11450.)

Principle subassemblies and components mounted on the pulse-generator chassis are the timing circuit board, output circuit board, attenuator, power supply, and front-panel controls and connectors. Portions of various circuits, such as resistors, capacitors, and switches, are also located on the chassis along with interconnecting wiring for power for power and signal distribution. An ac power receptacle, fuseholder, and cooling fan are located on the rear panel. A removable cover permits ready access to the interior of the instrument.

3-4 TIMING CIRCUIT BOARD SCHEMATIC

(Refer to Drawing Number D-11452, Sheets 1 and 2, and Figure 3-2).

a. TIMING CIRCUITS. The timing circuit determines the pulse repetition rate, the delay time, and the pulse width. The timing circuitry design makes extensive use of two-transistor, emitter-coupled, current mode switch circuits. These individual circuits provide complementary output pulses that are direct-coupled to succeeding stages with matched Zener diodes.

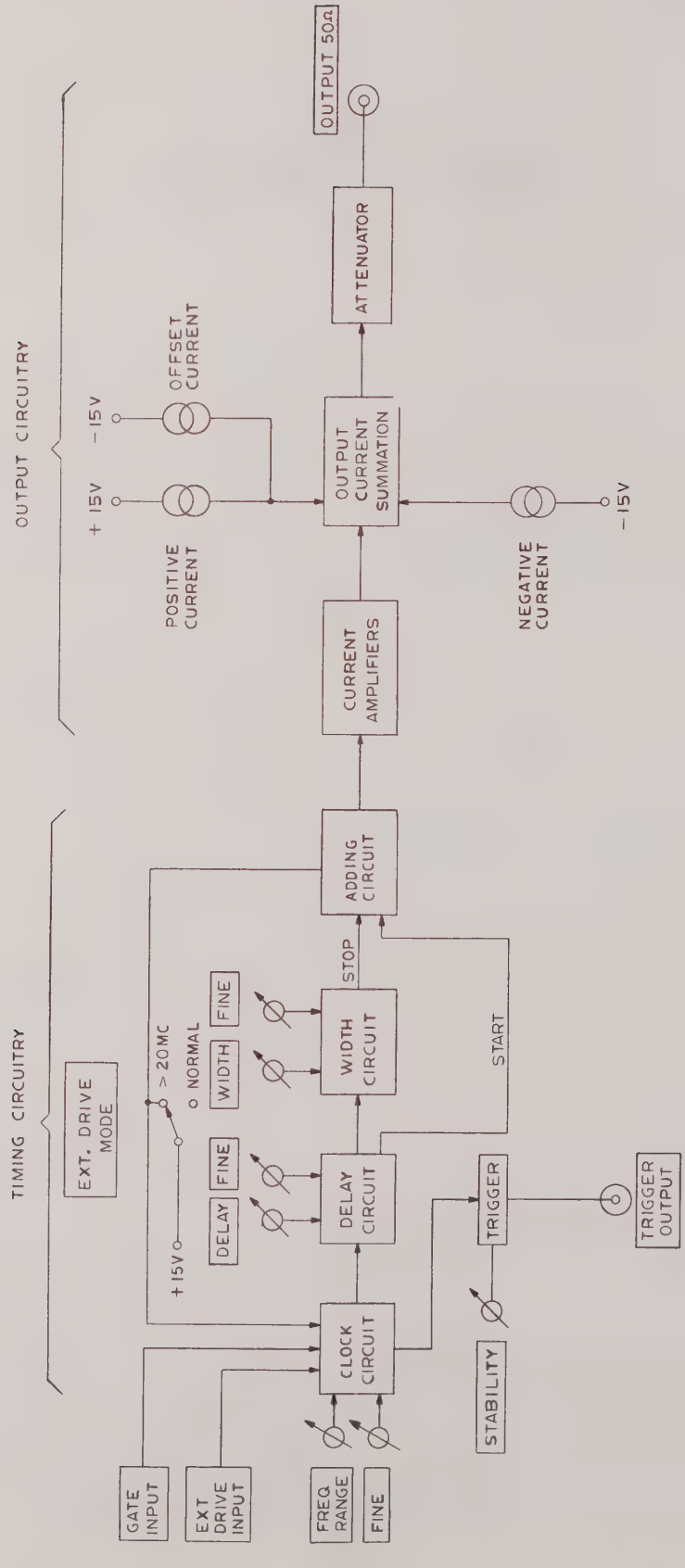


Figure 3-1 Model 122 Block Diagram

Pulse repetition rate is determined by an emitter-coupled astable multivibrator, Q8 and Q9. The period of the multivibrator is determined by selecting capacitor values (C201 through C211), in 1-3-10 sequence, by the front panel FREQ. RANGE control. The collectors of the multivibrator transistors are clamped by CR9 and CR10 to the emitter voltage of Q7. Fine frequency control is achieved by changing the collector clamp voltage of the multivibrator transistors. The collectors of Q8 and Q9 are cross-coupled to the opposite bases by Zener diodes. This tends to limit the voltage swing of the emitters; consequently, the time required to charge emitter-coupling capacitor C1 is controlled by the emitter clamp voltage of Q7. Q6 is a current source for Q8, one-half of multivibrator Q8 and Q9.

The output of the clock multivibrator is a square wave, which is dc coupled to the bases of current mode switch circuit Q10 and Q11. Q10 and Q11 are similarly coupled to a second current mode switch circuit, Q12 and Q13. The two current mode switch circuits are cascaded to ensure that the output signal is square and symmetrical, particularly at high frequencies. Q12 drives Q21, which is a common base amplifier, and Q21 drives the trigger output circuit.

The collectors of Q12 and Q13 are Zener diode coupled to the bases of Q15 and Q16. Q15 and Q16 form another current mode switch circuit that is used to initiate the time delay action. The time delay retards the output pulse so that it follows the trigger pulse by the selected delay time. Delay time is thereby defined as the time between the trigger pulse and the leading edge of the output pulse. The delay circuit operates by charging and discharging a selected capacitor with constant current. The voltage swing across the capacitor is clamped above and below chassis ground by two diodes, CR18 and CR19. As the delay-capacitor voltage reaches ground potential, it switches Schmitt trigger Q17 and Q18. Delay time is determined by the charging time of the selected delay capacitor.

Delay capacitors are selected by the DELAY range switch S203. In the 2/4 nanosecond range an inductive-resistive combination is used. In the 4/10 nanosecond range, distributed capacitance is employed rather than an actual capacitor.

Two constant current sources are provided: (1) a negative source, Q22, and (2) a positive source, Q14. Q14 is alternately connected and disconnected from the delay capacitor by the action of Q15 turning on and off. The positive and negative current sources are balanced so that the switch-selected delay capacitor charges in the positive direction at the same rate it discharges in the negative direction. The FINE (DELAY) control setting varies the collector current from the two current sources (Q14 and Q22). The Schmitt trigger (Q17, Q18) detects the charging voltage as it passes above or below ground potential and produces a pulse that is delayed with respect to the TRIGGER OUTPUT.

Q15 and Q16 operate as a current mode switch circuit. The collector potential of Q15 is clamped to within 0.7 volts above and below ground by diodes CR18 and CR19. The delay capacitor (C4 through C11) is individually selected by the DELAY selector switch S203 and is placed in parallel with the two diodes. The complementary square-wave input from Q12 and Q13 alternately switches Q15 and Q16 on and off. When Q15 is on, current from Q14 flows through Q15 to the delay capacitor. The capacitor charges, until its voltage equals the forward-voltage drop of CR19, where it is clamped. When Q12 and Q13 switch, Q15 turns off and Q16 turns on. The collector current of Q14 now flows through Q16 to ground. The collector of an additional transistor, Q22, is connected to the capacitor circuit. Q22 is a negative constant-current source which remains on. When Q15 turns off, Q22 begins to discharge the delay capacitor. The voltage across the delay capacitor goes negative, and when it reaches approximately -100 millivolts potential, the Schmitt trigger switches. Q22 supplies one-half the current of Q14; thus, the delay capacitor charges and discharges at the same rate. R207, the FINE delay control, determines the base bias of both Q14 and Q22, and controls the current available to the delay capacitor.

The output of the Schmitt trigger (Q17 and Q18) is Zener-diode dc coupled to another current mode switch circuit, Q19 and Q20, which is coupled to yet another current mode switch, Q23 and Q24. Switch Q23 and Q24 operates like the other switch circuits, but has two parallel complementary outputs. One output drives a pair of common base amplifiers, Q38 and Q39. The collectors of Q23 and Q24 see the input impedance of Q38 and Q39 as relatively low. Q38 and Q39 have sufficient gain to drive the following switch circuit, Q40 and Q41. The other output (from Q23 and Q24) drives the width current mode switch Q25 and Q26.

Operation of the width current mode switch is similar to that of the delay current mode switch. Q26 switches a constant current into the width capacitor. When the negative-going ramp reaches ground potential, the Schmitt trigger (Q27 and Q28) switches. The output of this Schmitt trigger drives another switch circuit, Q29 and Q30. The time delay generated by the width circuit corresponds to the pulse width at the output of the Model 122.

Q29 and Q30 drive two other switch circuits: 1) The collector of Q30 drives Q32 of current mode switch Q31, Q32. This switch circuit (Q31 and Q32) is part of a feedback circuit which is discussed as part of the gate input circuit. 2) The collector of Q29 drives Q33 of adder current mode switch Q33, Q34. It has two inputs; start pulse and stop pulse. The start pulse (from Q41) arrives at the base of Q34 at some time T_1; the stop pulse arrives at the base of Q33 (from Q29) at some later time T_2. The adder circuit combines the two inputs in such a way that the duration of the output, appearing at the collectors of Q33 and Q34, is equal to the time difference

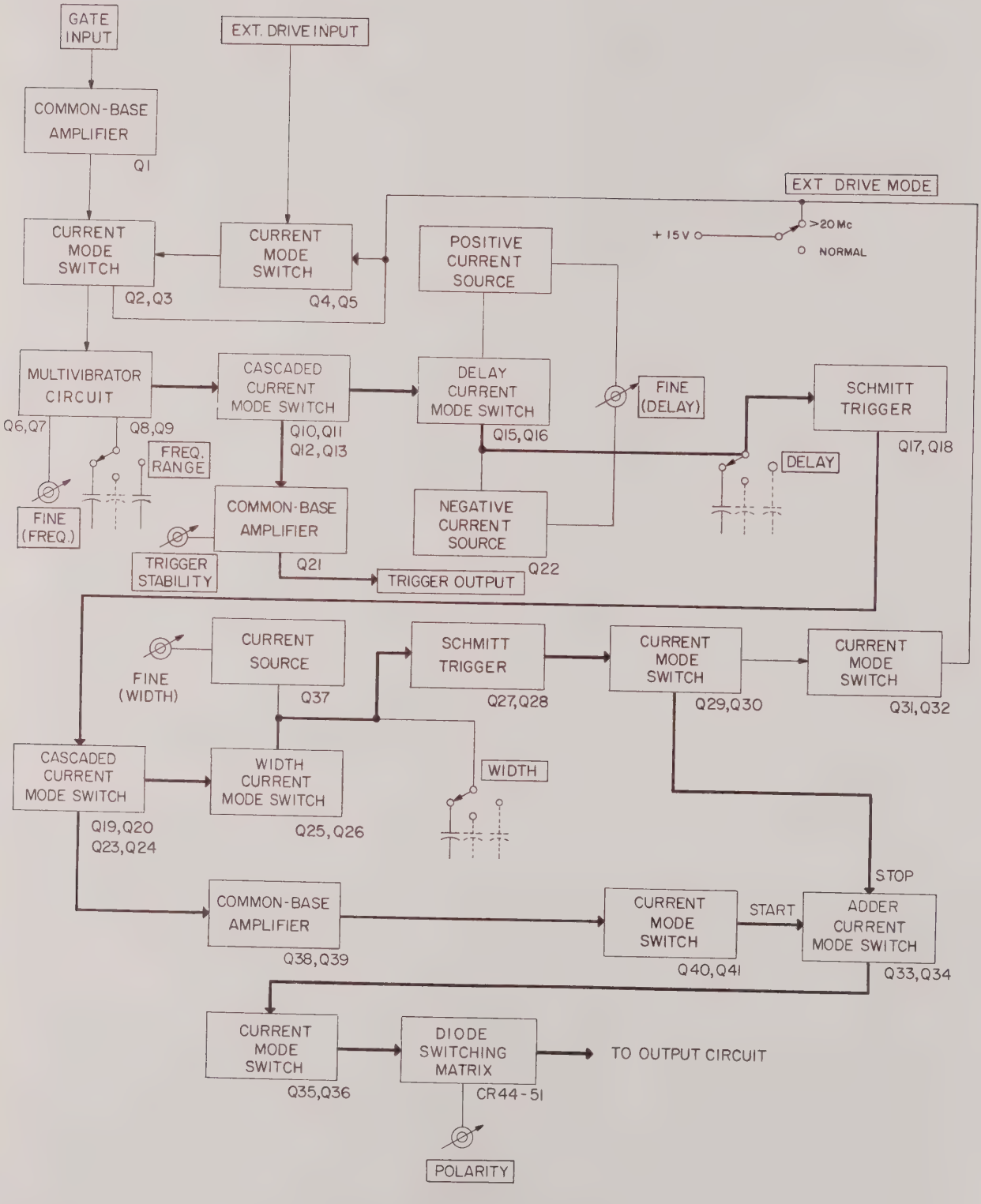


Figure 3-2 Timing Circuit Block Diagram

between the arrival of the start pulse and the stop pulse (width = $T_2 - T_1$). The output pulses of the collectors of Q33 and Q34 are complementary and simultaneous.

When the start pulse arrives from Q41, Q33 is on and Q34 is off. The start pulse arrives at the base of Q34 at time T_1, and the voltage drops from its quiescent value of approximately 7.6 volts to approximately 6.2 volts, which turns Q34 on. The emitter voltage drops to about 7.0 volts, which tends to turn Q33 off. At time T_2, the stop pulse arrives, and the base voltage of Q33 drops from about 6.8 volts to about 5.4 volts which tends to turn Q33 on and Q34 off again. The emitter voltage has now dropped to approximately 6.2 volts.

At some later time T_3, the start pulse terminates and the base voltage at Q34 goes back to its quiescent value of about 7.6 volts. The positive voltage rise at the base of Q34 has no effect because Q34 is already off. Q33, however, remains on until the end of the stop pulse (time T_4), and then its base voltage rises to about 6.8 volts. The emitter voltage also rises, and Q33 remains on until the next start pulse arrives. The outputs from the collectors of Q33 and Q34 are Zener-diode coupled to Q35 and Q36, which forms another current mode switch circuit.

The output pulses from Q35 and Q36 pass to a diode switching matrix CR44 through CR51. The switching network acts as a dc actuated, cross-strapped DPDT switch. Its purpose is to select the appropriate pulse polarity at the bases of Q1 and Q2 (on the output circuit board) according to the desired output pulse polarity. The POLARITY selector switch places the appropriate bias (-15 volts) on the anodes of the switch network diodes. For a positive normal output pulse, diodes CR44, CR45, CR50, and CR51 are back-biased, and diodes CR46, CR47, CR48, and CR49 are forward biased. In this manner, the positive pulse from the collector of Q35 is directed to the base of Q1 and the negative pulse from Q36 is directed to the base of Q2.

b. TRIGGER OUTPUT. The trigger output circuit provides a trigger output pulse, which may be used for synchronizing an oscilloscope, another pulse generator, or other instrument. The circuit consists of a tunnel diode multivibrator CR25, which operates in one of two modes. For pulse repetition frequencies above 3 megahertz, the tunnel diode circuit operates as a synchronized, free-running multivibrator and counts down to approximately 3 megahertz. For pulse repetition rates under about 3 megahertz, the tunnel diode circuit acts as a monostable multivibrator and switches at the pulse repetition frequency. TRIGGER STABILITY control R206 sets the bias current of tunnel diode CR25. The circuit behavior depends on the pulse repetition frequency and bias current.

c. GATE INPUT. The purpose of the gate input is to stop and start the pulse train as a function of the gate input signal. This is accomplished by turning on and off the clock multivibrator. The required gate input signal is -1 volt.

During normal operation, Q2 is off and Q3 is on. Since the emitter current of Q9 is supplied by Q3, when Q3 is off, the clock multivibrator is disabled. Potentiometer R105 provides adjustment of Q3 base bias so that the output of the clock multivibrator is a square wave. To ensure a symmetrical output, Q6 is placed between the +15 volt supply and Q8. The collector current of Q6 is fixed.

A negative gate pulse fed to Q1 will turn on Q2. Q2 and Q3 form a switch circuit, so that when Q2 turns on, Q3 turns off. When Q3 is off, the clock multivibrator is disabled. The positive going or trailing edge of the gate pulse turns Q2 off and Q3 turns back on; Q9 now has current available.

d. EXTERNAL DRIVE INPUT. The external drive circuit provides a means by which the E-H Model 122 may be driven and synchronized at a frequency determined by an external signal source. The required input signal must be at least +1.5 volts. The external drive circuit is placed in operation by setting the FREQ. RANGE selector switch to EXT. This disables the clock multivibrator until the external drive pulse re-enables it.

The Model 122 may be externally driven at any frequency from 1 kilohertz up to 100 megahertz. There are two external drive modes which are controlled by External Drive Mode switch S202. In the NORMAL position the output pulse is independent of the external drive pulse width. In the >20 MHz position, the width of the external drive pulse must be greater than the sum of the output pulse width plus the delay time. The switch should be placed in the >20 MHz position for external drive repetition frequencies above 20 megahertz.

In the NORMAL position, the External Drive Mode switch enables a feedback loop, so that the output pulse width is not a function of the input pulse width (as it is in the >20 MHz position).

Assume that the External Drive Mode switch is in the NORMAL position. Q2 and Q3, Q4 and Q5 are current mode switches. For external drive, Q4 is turned on, which turns Q5 and Q3 off, and turns Q2 on. With Q3 off, there is no emitter current available for Q9, so the clock multivibrator is disabled. A positive-going external drive pulse turns on Q5; Q5 turns on Q3, which turns Q2 off. With Q3 on, emitter current is available to Q9 so the multivibrator can begin a cycle, but it is prevented from free-running by the clamp action of CR12, CR13, and R27. Since the collector of Q2 is connected to the base of Q4, the base of Q4 is driven negative so that when the external drive pulse stops, Q4 is held off. At the end of the sum of delay and width times, a positive pulse from Q31 is fed back to the base of Q4. Q4 turns on and resets the external drive circuit. Under these conditions, the circuit

is indifferent to the width of the external drive pulse. The circuit will operate in this manner to approximately 20 megahertz.

When the External Drive Mode switch is set to >20 MHz, the feedback circuit (from the collector of Q31) is disabled. Switch S202 places a positive voltage at the anode of CR4. This clamps the collector of Q2 and the base of Q4 to ground potential. Under these conditions, the collector voltage of Q2 stays at approximately +0.5 volt with respect to chassis ground. The base of Q4 is likewise clamped, so that Q5 can now follow the external drive pulse. When Q5 turns off, Q3 follows to disable the clock multivibrator. During these conditions, the external drive pulse width must be greater than the sum of the delay time and the output pulse width.

3-5 OUTPUT CIRCUIT BOARD SCHEMATIC

(Refer to Drawing Number D-11453 and to Figure 3-3.)

a. OUTPUT CIRCUITS. Pulses from the timing circuit are coupled to Q1 and Q2 of the output circuit by the diode switch network CR44 through CR51. Q1 and Q2 form a current mode switch similar to those on the timing circuit. The next five switch circuits (Q3 through Q16) are likewise similar in design and operation.

There are two differences between the switch circuits in the timing circuit, and those in the output circuit. First, the timing circuit is referenced to chassis ground, while the output circuit is referenced to "floating ground". For positive mode output pulses, the "floating ground" is held at about -2.5 volts with respect to chassis ground. For negative mode pulses, it is held at about -7.5 volts. The "floating" +15 volt supply is referenced to the floating ground. The floating ground is used for biasing output transistor, Q20.

The second difference is that the emitter and collector resistors in the current-mode switch circuits decrease in value with each succeeding stage. The purpose is to provide current gain and low output impedance to drive output transistor Q20. The fourth and fifth circuits each use two transistors on each side of the switch to develop even greater current gain. In the final switch circuit, the collectors of Q13 and Q15 are grounded. The collectors of Q14 and Q16 are connected in parallel to the emitter of Q20.

The output transistor Q20 is a common-base, current mode switch. Its function is to switch negative current into the current summing junction at its collector. Current summing at the collector of Q20 enables the Model 122 to operate in four output pulse modes: +NORMAL, +INV., -NORMAL, -INV.

b. OUTPUT CURRENT SUMMATION. The pulse-output current-summation stage (Q20) has three current sources through stages Q17, Q19, and Q21. Q17 controls current to the +15 volt supply. Q19 and Q21 control current from the 15 volt supply. The algebraic sum is taken at the collector of Q20.

Regardless of output pulse polarity, the output transistor (Q20) switches negative current (from the collector of Q21) into the current summing junction. For baseline offset, Q19 supplies from 0 to -40 milliamperes. For -1 volt offset, Q19 supplies -40 milliamperes. For +1 volt offset, Q19 supplies no current. There is always at least +20 milliamperes from the positive source for summation with the baseline offset current so that for zero offset, Q19 supplies -20 milliamperes. The positive source (through Q17) supplies up to +120 milliamperes for positive pulse modes. For negative pulse modes, this current is reduced to +20 milliamperes for summation with the offset current.

For example, assume that the output pulse polarity is +NORMAL. During the quiescent state--between pulses--voltage at the emitter of Q20 is at the "floating ground," or -2.5 volts, and Q20 is on. If the output pulse amplitude is to be +5 volts across 50 ohms with no offset, the required output current is +100 milliamperes. The positive current source (Q17) provides +120 milliamperes; the offset current source (Q19) provides -20 milliamperes. Q20 is on, so the negative current supply--through Q21--provides -100 milliamperes. During quiescent conditions, the algebraic sum of the negative current, the positive current, and the offset current, equals 0 milliamperes (-100 +120 -20 = 0).

Since the base of Q20 is grounded, its output is in phase with its input. Therefore, the input at the emitter of Q20 must be a positive pulse. When the emitter of Q20 goes positive, it turns off, and the negative current is turned off. The sum of the offset and positive currents (+120 -20 = 100) flows through the attenuator to the output. At the end of the pulse, the input signal at the emitter of Q20 returns to about -2.75 volts. Q22 turns on, and the current sum is again 0 milliamperes.

For an inverted positive pulse, the input signal polarity at the emitter of Q20 must also be inverted. This emphasizes the necessity for being able to reverse the polarity of the pulses at the input to the output circuit board (Q1 and Q2). The quiescent emitter voltage of Q20 is at approximately -2 volts. Since the base of Q20 is approximately -2.5 volts, Q20 remains off. During quiescence, the positive current plus the offset current equals +100 milliamperes (+120 -20). A negative pulse turns Q20 on, and allows -100 milliamperes to flow to the collector. Output current is now (-100 +120 -20 = 0). When the input signal returns to its quiescent level, Q20 switches off and the output voltage returns to +5 volts.

Excluding input-pulse polarity, the only difference between positive pulse mode operation and negative

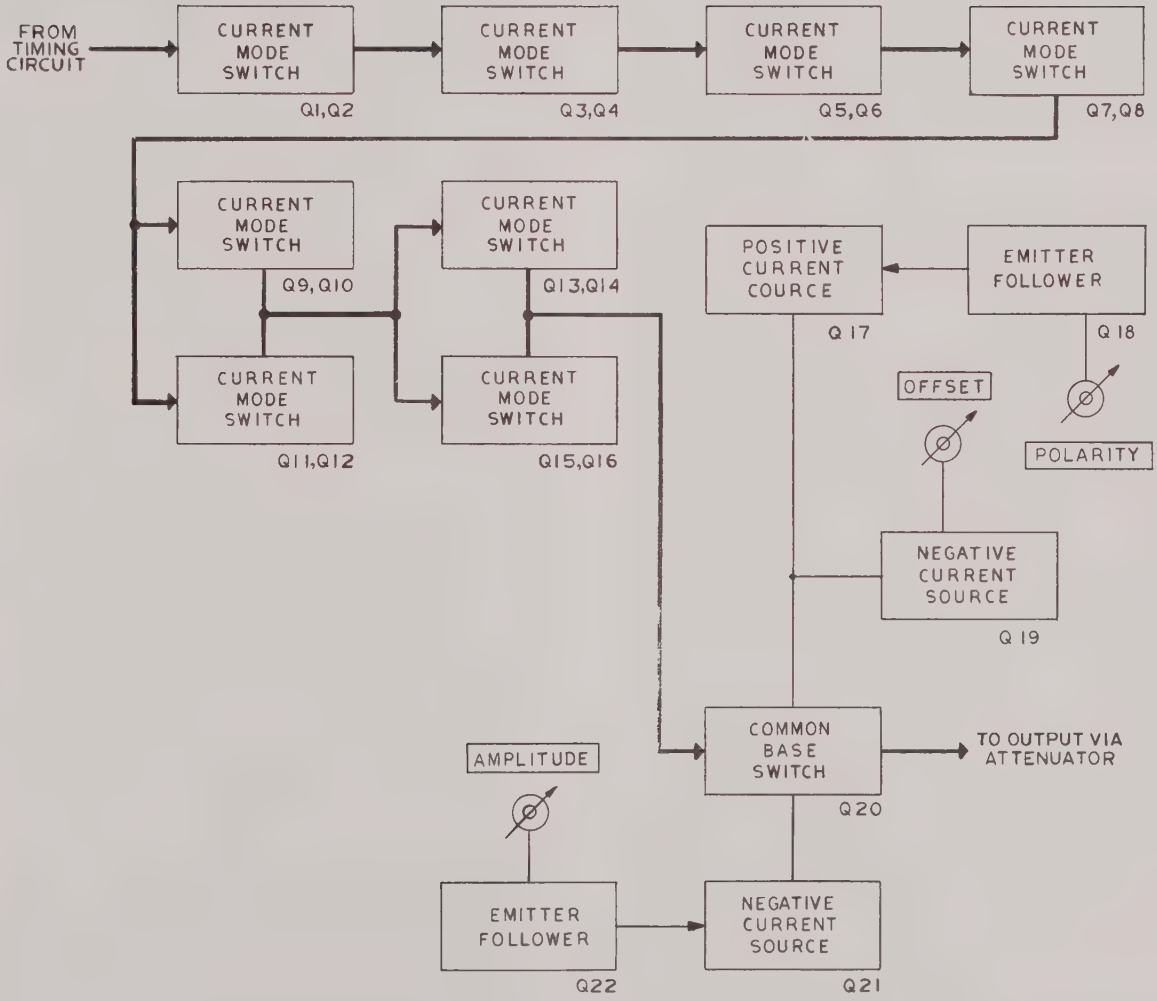


Figure 3-3 Output Circuit Block Diagram

pulse mode operation is that the voltage at the base of Q20 is shifted negatively by approximately 5 volts with respect to chassis ground. This negative voltage level change is required to provide proper bias levels on Q20.

c. OUTPUT CURRENT SOURCES. The three currents summed at the collector of Q20 originate in the following manner: Q21 and Q22 are the negative current source. Q21 is always on and provides -100 milliamperes. The output of Q21 is controlled by emitter follower Q22. The collector current of Q21 is the negative current switched by Q20. The positive current source operates in a similar manner: Q 17 provides up to + 120 milliamperes. Its output is controlled by emitter follower Q18. The baseline offset current is supplied by Q19. The base bias of Q19 is controlled by R209, and is adjustable for current output from 0 to -40 milliamperes.

d. AMPLITUDE CONTROL. Potentiometer R210 is the amplitude control. It is wired as a variable resistor between the positive and negative buses. R210 controls the current between the two 15 volt buses, which, in turn, controls the IR drop across R58 and R59 for the negative source, and CR15, R51, and R52 for the positive current source. The IR drop across the series combination of R58 and R59 controls the base bias of Q22, which, in turn, controls the negative current source. The IR drop across the series combination of CR15, R51, and R52 controls the base bias of Q18, which controls the positive current source. During the negative pulse mode operation the polarity switch connects the base of Q18 to the junction of CR15 and R51. The base voltage of Q18 is now only one forward-diode-voltage drop away from its collector voltage and so Q18 turns on. The emitter voltage of Q18 rises towards +15 volts which tends to turn Q17 off. The collector current of Q19 is thereby reduced to approximately +20 milliamperes. This current is added to the collector current from Q17 to provide baseline offset current during negative pulse modes. The 100-ohm trimming potentiometer (R52) adjusts the positive current source for correct baseline offset in positive pulse modes. Another 100-ohm trimming potentiometer (R59) adjusts the negative current source for zero baseline offset during negative pulse mode operation.

3-6 ATTENUATOR SCHEMATIC

(Refer to Drawing Number C-11454)

The output attenuator is connected between summing-stage Q20 on the output circuit board and OUTPUT 50 Ω connector J204 on the front panel. The attenuator permits coarse output level selection. Any one of four resistive attenuators or a straight-through connection may be switch-selected. The switch-selected attenuator ranges are: 1:1, 2:1, 4:1, 8:1, and 16:1 permitting output amplitude to be adjusted from ± 5 volts to ± 150 millivolts.

3-7 POWER SUPPLY SCHEMATIC

(Refer to Drawing Number D-11451)

a. TRANSFORMER, RECTIFIER AND FILTER CIRCUITS. Power transformer T101 is factory wired for service with 117 vac power lines. For 234 vac service, the primary winding should be reconnected in series, as indicated on the power supply schematic. The power transformer has two secondary windings. The output of one is rectified by the bridge circuit (CR101 through CR104), and filtered by choke L101 and capacitor C102, and then regulated at +15 volts with respect to chassis ground. The other secondary winding is center tapped; its output is rectified by full-wave rectifiers CR105 and CR106, filtered by C101, and regulated at -15 volts with respect to chassis ground.

b. REGULATORS. The power supply has three regulator circuits: +15 volts (with respect to chassis ground), -15 volts (with respect to chassis ground), and +15 volts (with respect to the "floating ground").

In the +15 volt regulator, Q101 is the pass element in a series regulator circuit. Q2 is connected to Q101 in a Darlington configuration, and is driven by the collector of Q1. Q1 and Q3 form an emitter-coupled differential amplifier circuit. The base of Q3 is referenced by CR3; any change in output voltage level will be sensed by the base of Q1 at the junction of R2 and R3. R103, which is in series with R3, provides output voltage adjustment.

In the -15 volt regulator, Q104 and Q105 are connected in parallel as the pass element in a series voltage regulator. Q4 provides current gain to drive Q104 and Q105. Q4 is driven by Q5. Q5 is the feedback amplifier and is referenced to the +15 volt bus. Any variation in the output voltage will appear as a bias change at the junction of R14 and R18. For example, if the -15 volt bus should go positive, the base of Q5 also goes positive. Q5 conducts less, and its collector voltage goes negative to drive the base of Q4 negative. The emitter of Q4 follows, and drives the bases of Q104 and Q105 negative. The voltage drop across the pass transistors decreases, and the output voltage returns to -15 volts.

In the floating +15 volt regulator, proper biasing of output transistor Q20 (Drawing Number D-11453) requires that its base be negative with respect to its collector. To this end, a floating power supply holds the base of Q20 in the output circuit at approximately -2.5 volts for positive-mode output pulses and -7.5 volts for negative-mode output pulses. The floating 15 volt supply bus is held at +15 volts with respect to the floating ground. The voltage divider R42, R43, and R44 (in the output circuit, Drawing Number D-11453) determines the potential of the floating ground. The proper level is selected by POLARITY switch S206. The potential selected is applied to the base of Q10 in the power supply circuit. The emitter voltage of Q10 drives the base of Q6 (Q7 serves in this circuit as an emitter-current source for Q8 and Q10). The emitter voltage of Q6 follows its base voltage and drives Q102.

The emitter voltage of Q102 is the actual voltage of "floating ground".

When the floating ground or reference-voltage level is established, the regulator circuit establishes a second level which is 15 volts positive with respect to the floating ground. Zener diode CR7 is a reference that is -5 volts below the floating ground. Between the -5 volt and +15 volt levels (floating), there is a voltage divider network formed by R11, R12 and R104 that biases Q8. Q8 is one-half of a differential amplifier circuit; its output is taken from the collector of Q10 and applied to the base of emitter-follower Q9, to drive Q103, so that the collector voltage of Q103 remains 15 volts positive with respect to the floating ground or reference level.

When the output-pulse mode is changed from positive to negative, the voltage of the floating ground drops from (approximately) -2.5 to -7.5 volts. The voltage at the anode of CR7 goes negative 5 volts, and causes the whole system to shift levels; thus, the collector voltage of Q103 drops from +13 volts to about +8 volts. This establishes the correct bias levels at the base of output transistor Q20.

SECTION 4
MAINTENANCE

4-1 GENERAL

The E-H Model 122 requires a minimum amount of maintenance; however, normal aging of electronic components may eventually cause abnormal operation. Therefore, general maintenance and trouble-shooting information is included in this section as a guide to restoring the instrument to normal operation.

4-2 ROUTINE MAINTENANCE

A regular program for maintenance and inspection every four to six months is recommended to effectively minimize the probability of equipment down time. The unit should be carefully checked in the following manner:

a. Remove the Model 122 cover panels.

b. Make a thorough inspection of all wiring and cables. Check for frayed, loose or burnt wires.

c. Check the physical integrity of all components. Look for evidence of burning or cracking, loose solder connections, leakage of insulation compound, and general physical damage.

d. Check all switches and controls for loose or broken terminals, tight or sticking shafts, etc.

e. If the internal panel surfaces and components have an excessive amount of dust or lint deposited on them, use a low pressure stream of air to remove the foreign material.

CAUTION

Do not clean the circuit boards or small internal components with a wiping cloth or solvents, since damage to the circuits may result.

f. Wipe the external instrument surfaces with a soft, damp cloth to remove dirt, fingerprints, and other foreign material.

g. Lubricate the ventilation fan by placing two drops of instrument oil on each bearing pad. Wipe any excess oil and dirt from the fan surfaces.

h. Check operation of the instrument in accordance with SECTION 4-3, PERFORMANCE VERIFICATION.

i. Replace the cover panels if all checks indicate that the instrument is operating properly.

4-3 PERFORMANCE VERIFICATION

E-H Model 122 performance can be verified by the basic procedures outlined in this section. While performing these checks, it is important that the proper test equipment be utilized, to ensure accurate test results. Suggested test equipment is listed below.

a. TEST EQUIPMENT

(1) Oscilloscope: to provide the following test capabilities; sweep calibrated to approximately 1 nanosecond/centimeter, dual trace vertical amplifiers with vertical sensitivity of at least 10 millivolts/centimeter and risetime of less than 350 picoseconds. An oscilloscope that meets these specifications is the Tektronix (TEA) Type 661 with a Type 4S1, Type 5T1A, or Type 5T3 Plug-in unit. This is a sampling oscilloscope with low input impedance. For trouble-shooting, it should be used with a cathode-follower probe to provide a high input impedance. An alternative (for trouble-shooting), is the Tektronix Type 541 oscilloscope with Type L Plug-in unit.

(2) DC Voltmeter: that provides greater than 20k ohm/volt input impedance; accuracy and resolution to at least 0.2%; dc voltage scales of 0 to 25 volts. A suitable dc voltmeter is Fluke (FLA) Model 801, 803, or 825.

(3) Pulse Generator: that provides a variable repetition rate up to approximately 100 megahertz with risetimes less than 1 nanosecond/volt, and output pulse amplitude of at least ± 1.5 volts into a 50-ohm load. A suitable pulse generator would be another E-H Model 122.

(4) Attenuator: 50 Ω, 10:1, capable of dissipating 1 watt. A suitable attenuator is the Tektronix 10XT 50-ohm attenuator (017-0044-00). This attenuator at the input of the sampling oscilloscope prevents overdriving of the input channel.

b. REPETITION RATE CHECKOUT. Operation of the FREQ. RANGE controls may be checked as follows:

(1) Connect the attenuator to the OUTPUT 50 Ω connector of the Model 122. Also connect a short length of 50-ohm coaxial cable, such as RG213/U, between the attenuator and the oscilloscope input-channel connector.

(2) Turn the Model 122 power on. Leave the 50-ohm attenuator connected during each operation.

NOTE

In the following step, more stable operation usually results when a 5:1 or 2:1 attenuator is connected at the Model 122 TRIGGER OUTPUT in series with the cable to the oscilloscope external-trigger input.

(3) Connect a 50-ohm cable from the TRIGGER OUTPUT of the Model 122 to the external trigger input of the oscilloscope. Adjust the TRIGGER STABILITY control for consistent, stable triggering. This may be necessary each time the frequency controls are changed.

(4) Set the DELAY selector switch to the 2/4 nanosecond position; set the FINE (DELAY) control to minimum (fully counterclockwise).

(5) Set the WIDTH selector switch to the 2/4 nanosecond position; set the FINE (WIDTH) control to minimum (fully counterclockwise). At lower repetition rates, increase the pulse width and delay for easier observation.

(6) Set the AMPLITUDE, ATTENUATOR, OFFSET and POLARITY controls at any convenient setting while observing the output pulse.

(7) At each point on the FREQ. RANGE selector switch, vary the FINE (FREQ. RANGE) control from minimum to maximum. Pulse repetition rate should be variable from less than 1 kilohertz to more than 200 megahertz. The FINE control should provide continuous adjustment over each range, with overlap to adjacent ranges.

NOTE

Neither delay time nor width time should exceed 40% of the pulse period or unusual pulse distortion patterns will appear.

See SECTION 2-6 a, OUTPUT PULSE DROPOUT for special operating information.

c. DELAY CHECKOUT. Check the operation of the DELAY controls with the dual trace oscilloscope as follows:

(1) Connect Channel A of the oscilloscope through the attenuator to the Model 122 OUTPUT 50 Ω connector. Connect the Model 122 TRIGGER OUTPUT to Channel B of the oscilloscope to observe the trigger pulse. (The trigger stability control may require adjustment.) Trigger the oscilloscope internally on the trigger pulse.

(2) Set the FREQ. RANGE selector switch and the FINE (FREQ. RANGE) control to any convenient position.

(3) Set the WIDTH and DELAY controls to any convenient setting.

(4) Set the AMPLITUDE, ATTENUATOR, OFFSET, and POLARITY controls to any convenient position.

(5) Set the sweep speed of the oscilloscope (TIME/CM) to display two or three periods of the OUTPUT 50 Ω and TRIGGER OUTPUT pulses.

NOTE

In the following step, as delay time is increased, pulse repetition rate should be decreased. Pulse width can be adjusted, as required, for best waveform presentation.

(6) Measure delay time between the leading edge of the TRIGGER OUTPUT pulse and the leading edge of the OUTPUT 50 Ω pulse. Delay time should be variable from less than 2 nanoseconds to more than 100 microseconds. An additional 12 nanosecond delay will be evident on the low DELAY ranges. This is due to the inherent fixed delay in the OUTPUT 50 Ω circuit.

The FINE (DELAY) control should provide continuously variable delay time on each range of the DELAY selector switch, with overlap to adjacent ranges. When the pulse repetition rate is increased above 3 megahertz, the trigger circuit counts down to about 3 megahertz. If the TRIGGER OUTPUT pulse is unstable, adjust the TRIGGER STABILITY control for a stable presentation.

d. PULSE WIDTH CHECKOUT. Check the operation of the WIDTH controls as follows:

(1) Re-connect the oscilloscope as described in SECTION 4-3 b, REPETITION RATE CHECKOUT.

(2) Set the ATTENUATOR selector switch

selector switch to 1, and the AMPLITUDE control to any convenient position.

(3) Pulse width is the time measured between the 50% amplitude points on the leading and trailing edges of the pulse. Pulse width should be variable from less than 2 nanoseconds to more than 100 microseconds. The FINE (WIDTH) control should provide continuous adjustment over each range, with overlap to adjacent ranges.

NOTE

Pulse repetition rate and delay time should be decreased as the pulse width is increased.

e. AMPLITUDE CHECKOUT. Operation of the AMPLITUDE control may be checked as follows:

(1) Set the FREQ. RANGE controls to any convenient position.

(2) Set the WIDTH and DELAY controls so that the WIDTH plus DELAY time is less than 40% of the pulse repetition period.

(3) Set the ATTENUATOR selector switch to 1 and the AMPLITUDE control to maximum (fully clockwise).

(4) With the oscilloscope, observe the amplitude of the OUTPUT 50Ω pulse across the 50-ohm load. The output pulse should be at least 5 volts in amplitude for each position of the POLARITY selector switch. The POLARITY selector switch has four positions.

The AMPLITUDE control, in conjunction with the 5-position ATTENUATOR selector switch, provides continuously variable control of output pulse amplitude from ± 5 volts to ± 150 millivolts.

f. OFFSET CHECKOUT. Operation of the output-pulse OFFSET control may be checked as follows:

(1) Set the Model 122 front panel controls to any convenient pulse repetition rate, width, delay, and amplitude. Set the ATTENUATOR selector switch to the 1 position (fully counterclockwise), and the POLARITY selector switch to the +NORMAL position.

(2) Observe the amplitude and baseline of the output pulse train on the oscilloscope.

(3) Vary the OFFSET control from limit to limit. The pulse baseline should vary from at least -1 volt to +1 volt. Offset modes are illustrated in SECTION 2-6 d, Figure 2-2.

The OFFSET control should operate similarly at each position of the POLARITY selector switch. The offset amplitude is attenuated when the attenuator switch is set at any position other than 1.

g. POLARITY CHECKOUT. Output pulse POLARITY modes may be checked as follows:

(1) Set the Model 122 front panel controls to any convenient pulse repetition rate, width and delay. Set the OFFSET control to the center of the range.

(2) Observe the output pulse polarity on the oscilloscope.

(3) Set the POLARITY selector switch in sequence, to + NORMAL, + INV, - NORMAL, and - INV. The output-pulse train should appear in the selected POLARITY mode. Polarity modes are illustrated in SECTION 2-6 c, Figure 2-1.

h. ATTENUATOR CHECKOUT. Check the operation of the internal ATTENUATOR as follows:

(1) Set the Model 122 front panel controls to any convenient pulse repetition rate, width, and delay.

(2) Set the ATTENUATOR selector switch to 1. Observe the amplitude of the output pulse on the oscilloscope. Then turn the ATTENUATOR selector switch through the other switch positions, while again observing the amplitude of the output pulse. Compare the output pulse amplitude at each ATTENUATOR position to that of position 1. The attenuation ratios of 1:1, 2:1, 4:1, 8:1, and 16:1 observed on the oscilloscope should be within 10% of the front panel markings.

i. EXTERNAL DRIVE INPUT CHECKOUT. Check the operation of the EXT. DRIVE INPUT circuit as follows:

(1) Set the Model 122 FREQ. RANGE selector switch to EXT.

(2) Adjust the test pulse generator to any convenient frequency from 1 kilohertz to 100 megahertz. Set the test pulse generator polarity to positive, and the amplitude to 1.5 volts. Connect the test pulse generator output to the Model 122 EXT. DRIVE INPUT connector. The risetime of the external drive pulse should be as short as possible; ideally, about 1 nanosecond/volt.

(3) For pulse repetition rates greater than 20 megahertz, set the External Drive Mode toggle switch to >20 MHz. For lower frequencies, leave this switch in the NORMAL position. When the external drive repetition rate is greater than 20 MHz, the external drive pulse width should be greater than the sum of the Model 122 output pulse width plus delay time.

(4) Observe the Model 122 output pulse on the oscilloscope. The Model 122 output pulse repetition rate should be variable from 1 kilohertz to 100 megahertz, according to the repetition rate setting of the test pulse generator.

j. GATE INPUT CHECKOUT. The operation of the GATE INPUT circuit is checked as follows:

(1) Adjust the Model 122 FREQ. RANGE controls for the desired pulse repetition rate.

(2) Adjust the test pulse generator so that the gate pulse repetition frequency is less than that of the Model 122. The period of the gate signal should be greater than that of the Model 122 output signal.

(3) If necessary, adjust the pulse width of the test pulse generator to some value greater than the Model 122 pulse repetition period. The gate pulse width corresponds to the time between the last pulse of one burst, and the first pulse of the following burst. The risetime of the gate pulse should be as short as possible; ideally, about 1 nanosecond per volt.

(4) Connect the output of the test pulse generator to the GATE INPUT of the Model 122.

(5) Connect the trigger pulse of the test pulse generator to the external trigger input connector of the oscilloscope. With the oscilloscope, observe the Model 122 output pulse bursts.

For an example of gate operation, see SECTION 2-6 e, GATE INPUT OPERATION.

It should be possible to obtain a stable pulse burst display by adjusting the test pulse generator width control. As this control is adjusted (upward or downward), the display will alternately become stable, then unstable. Notice that the number of pulses in the output burst will decrease or increase each time a new stable display is achieved.

k. TRIGGER OUTPUT/TRIGGER STABILITY. The trigger circuit is used in conjunction with the delay circuit, so that operation of the TRIGGER OUTPUT/TRIGGER STABILITY controls may be verified as outlined in SECTION 4-3 c, DELAY CHECKOUT.

4-4 TROUBLE-SHOOTING

If the Model 122 fails to operate properly, it is first recommended that SECTION 4-3, PERFORMANCE VERIFICATION, be carefully read to ensure that all conditions are present for proper operation. If the instrument still does not function properly after making these checks, the following trouble-shooting procedures are recommended as a guide for isolating the problem.

a. MALFUNCTION CONFIRMATION

(1) Be sure that there is a malfunction before assuming a fault in the instrument. Check the oscilloscope, the output termination, and the pulse transmission line.

(2) Make a thorough visual inspection. Many times a fault can be located before turning the instrument on. Look for a blown fuse, unplugged power cord, burned resistors, loose or pinched wires, components not seated properly in their sockets, etc.

(3) Thorough familiarity with the functional block and schematic diagrams is necessary for intelligent servicing of the Model 122. The schematic drawings show typical waveforms that are associated with test points at various locations in the circuit. Also, a few minutes spent in learning the instrument layout and theory of operation will greatly increase trouble-shooting efficiency.

b. POWER SUPPLY CHECK (See Table 4-1)

(1) Check the +15 volt supply with a dc voltmeter. If necessary, adjust the output voltage with the +15 volt adjust, R103.

(2) Check the -15 volt supply with a dc voltmeter. If output voltage is incorrect, check for and replace any defective components.

(3) Check the +15 volt (floating) supply with a dc voltmeter. If necessary, adjust the output voltage with the +15 volt floating adjust, R104.

c. TIMING/OUTPUT CIRCUIT CHECK

(1) If the dc power supplies are functioning properly, check the timing/output circuits for a malfunction. Determine the defective block by checking symptoms and waveforms. A convenient division of circuits is between the timing and output boards--just as the schematic drawings are divided.

(2) The timing circuit should deliver simultaneous complementary pulses to the output circuit.

A check for these pulses will determine if the timing circuit is functioning properly. If correct waveforms are not indicated, check the timing circuit. If the timing pulses are correct, but the output pulses are not correct, check the output circuits.

NOTE

Several points in the circuitry are critical; shunt capacitance and circuit loading by the oscilloscope might seriously affect circuit operation.

(3) Throughout the timing circuits, Zener diodes with series resistors are used for transistor bias. These may be easily checked with the dc voltmeter. The forward voltage drop across a germanium diode should be approximately 300 to 500 millivolts. The voltage drop across a silicon diode should be approximately 600 to 800 millivolts.

Germanium devices tend to be more susceptible to failure than silicon devices.

(4) In four-transistor complexes, it is not easy to identify the faulty transistor. Simultaneous replacement of all four may be the quickest way to confirm component failure.

(5) If low output occurs, be sure the load seen by the output of the Model 122 is 50 ohms. Use a short length of good quality 50-ohm cable (e.g., RG213/U) at the output. Be sure to check connectors, transmission line, and output-load devices for proper interconnection and operation.

d. TIMING CIRCUIT ADJUSTMENTS. The following adjustments should be made only if timing circuit components have been replaced, or there is difficulty in obtaining an output signal in the highest frequency ranges (30 to 200 megahertz).

In making these adjustments, use only a high-input impedance oscilloscope, or a sampling oscilloscope with a cathode-follower probe. Circuit loading by oscilloscope probes is a critical factor.

Confirm that there is a malfunction in the high frequency ranges, as outlined in SECTION 4-3, PERFORMANCE VERIFICATION, and SECTION 4-4, TROUBLE-SHOOTING. Make sure that any defective components are replaced. Do not make unnecessary adjustments.

CAUTION

The following internal adjustments are made at the factory by trained personnel. Adjustments should not be attempted by persons unfamiliar with the Model 122.

(1) Remove the Model 122 cover panels.

(2) Set the FREQ. RANGE selector switch to the 1/3 MHz position and the FINE (FREQ. RANGE) control to minimum (fully counterclockwise). Adjust the WIDTH selector switch to the 100/300 ns range and the FINE (WIDTH) control to minimum (fully counterclockwise). Set the DELAY and FINE (DELAY) controls to minimum (fully counterclockwise).

(3) Observe the signal at the collector of Q10 on the timing board. Adjust R105 (located on the chassis) so that the square wave at the collector of Q10 is as symmetrical as possible. At 1 megahertz, each half cycle should be 500 nanoseconds in duration.

(4) Observe the signal at the junction of R51 and R52. Adjust R106 (located on the chassis) so that the voltage excursions of the signal above and below ground potential are equal.

(5) Observe the signal at the junction of R94 and R95. Adjust R107 (located on the chassis) as indicated in step 4 above.

NOTE

The adjustment outlined in step (6) is critical, and is extremely sensitive to loading by oscilloscope probes.

(6) Observe the signal at the emitters of Q33 and Q34. Compare the observed waveform with that indicated on the timing circuit schematic drawing. The width of the "step" on the negative going portion of this waveform corresponds to the output pulse width. Adjust R115 (located on the timing circuit board) so that the voltage level of the step is half-way between the top and bottom of the waveform.

e. OUTPUT CIRCUIT ADJUSTMENTS. The following procedures should also be incorporated with those described in SECTION 4-4 d, TIMING CIRCUIT ADJUSTMENT.

(1) Output amplitude should be calibrated if the need is evident. Set the ATTENUATOR at 1, the POLARITY selector switch at +INV, and the AMPLITUDE control to maximum (fully clockwise).

(2) With the oscilloscope, observe the OUTPUT 50 Ω signal. Adjust R59, located on the output circuit board, so that the pulse output amplitude is 5.1 volts. (R59 is the lower potentiometer.)

(3) Set the POLARITY selector switch to + NORMAL. Observe the OUTPUT 50 Ω signal. Leave the ATTENUATOR selector switch set at 1.

(4) Vary the AMPLITUDE control from maximum to minimum. At the same time, adjust R52 (the other potentiometer on the output circuit board) for minimum baseline shift.

(5) Check operation of the instrument in accordance with SECTION 4-3, PERFORMANCE VERIFICATION.

(6) Replace the cover panels if all checks indicate that the instrument is operating properly.

TABLE 4-1 E-H MODEL 122 POWER SUPPLY VOLTAGES

TERMINAL NUMBER *	VOLTAGE **				
	NOMINAL (dc)	MAXIMUM (dc)	MINIMUM (dc)	RIPPLE (p-p)	REMARKS
1	- - -	- - -	- - -	- - -	Chassis ground
2	-15.0	-15.5	-14.5	<20 mv	No adjustment
5	-7.6 or -2.4	- - -	- - -	- - -	Reference voltages; selected by POLARITY switch S206 (derived from -15 volt source).
8	+15.0 ("floating")	+16.0	+14.0	<20 mv	Variable; adjust +15 volt FLOATING, R104
11	-7.6 or -2.4			<10 mv	"Floating ground"
18	+15.0	+15.5	+14.5	<20 mv	Variable; adjust +15 volt ADJ, R103

* Refer to Power Supply Schematic, Drawing Number D-11451, and to Master Schematic, Drawing Number D-11450.

** Measure all voltages with respect to chassis ground, except the +15 volt dc floating supply, which must be measured between terminals 8 (+15 volt dc) and 11 (floating or reference ground).

SECTION 5
PARTS LIST

5-1 ORDERING INFORMATION

Replacement parts may be ordered through your E-H Representative or from the factory. To be certain that you receive the proper replacement parts, always include the following information with your order:

a. Model Number and Serial Number of the instrument on which the replacement parts will be installed.

b. Circuit or Drawing Reference for which each part is intended.

c. E-H Part Number.

This instrument contains several factory-selected components to ensure optimum performance. In no case should a diode or transistor be replaced with one from a different manufacturer, unless it is on the specific recommendation of E-H.

When replacement parts are necessary, be sure to order through the E-H Customer Service organization. In this way, we can best serve you by providing up-to-date factory recommended parts and service information.

5-2 WARRANTY

This instrument is guaranteed to be free from defects in material and workmanship. Our obligation is limited to repairing the instrument should it prove to be defective, upon our examination, within one (1) year after the purchase date. Fuses and batteries are specifically excluded from warranty. Electron tubes, transistors, and diodes are warranted for six (6) months.

For In-Warranty repair of this instrument, contact E-H Research Laboratories, Inc., Customer Service Department, and provide:

a. Instrument Model Number and Serial Number.

b. Full details concerning the nature of the malfunction.

Shipping instructions, or repair information and parts, will be sent to you promptly.

CUSTOMER SERVICE DEPARTMENT, E-H RESEARCH LABORATORIES, INC.

163 ADELINE STREET, OAKLAND, CALIFORNIA - Phone: TE 4-3030, Area Code 415

5-3 TIMING CIRCUIT BOARD

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
	P. C. Board, Timing	B11200
C1	Capacitor, P. C., 10pf	A11438
C2, 7, 15	Cap., Cer., .01mfd, 10%	311-012
C3, 11, 19	Cap., Cer., .001μf, ±20%	311-010
C8, 16	Cap., Cer., .004μf, ±20%	311-042
C6, 14	Cap., Cer., .04μf, ±20%	311-043
C5, 13	Cap., Cer., .1μf, ±20%	311-034
C4, 12	Cap., Cer., .33μf, ±20%	311-045
C9, 17	Cap., Cer., .68pf, ±20%	311-044
C10, 18	Cap., Cer., 330pf, ±20%	311-029
L4, 5	Choke and Resistor Assembly	A11437
CR13	Diode, zener, 1N753A	374-058
CR43	Diode, zener, 1N751A	374-022
CR3, 5, 8, 11, 14, 15, 17, 20, 21, 22, 23, 24, 27, 28, 29, 30, 33, 34, 35, 36, 37, 38, 39, 40. 41, 42	Diode, zener, 1N751A (Matched Pairs)	A11732
CR26	Diode, zener, 1N749A	374-044
CR16	Diode, 1N914B	376-022
CR1, 2, 6, 44 to 51.	Diode 1N270	376-031
CR9, 10	Diode, 1N830A, (Matched Pairs)	A11738
CR4, 7	Diode, CGD1419	376-046
CR12, 18, 19, 31, 32	Diode, FD777	376-059
CR25	Diode, Tunnel, TD254A	376-060
R135, 136	Resistor, 5.1Ω, 1/4W, 5%	595-051
R119, 122	Resistor, 8.2Ω, 1/4W, 5%	595-082
R64	Resistor, 11Ω, 1/4W, 5%	595-110
R52, 95	Resistor, 15Ω, 1/4W, 5%	595-150
R29, 32, 36, 39, 43, 46, 49, 56, 60, 79, 82, 87, 89, 92, 99, 103	Resistor, 24Ω, 1/8W, 5%	594-240
R106, 110	Resistor, 24Ω, 1/4W, 5%	595-240
R51, 94	Resistor, 36Ω, 1/4W, 5%	595-360
R23, 25, 31, 33, 38, 53, 58, 59, 80, 83, 96, 102, 113, 114	Resistor, 51Ω, 1/8W, 5%	594-510
R1, 18	Resistor, 56Ω, 1/4W, 5%	595-560
R132, 134	Resistor, 68Ω, 1/4W, 5%	595-680
R9, 67, 100, 117	Resistor, 100Ω, 1/4W, 5%	595-101
R45, 63, 66, 107	Resistor, 51Ω, 1/4W, 5%	595-510
R8, 22, 24, 26	Resistor, 110Ω, 1/4W, 5%	595-111
R10	Resistor, 130Ω, 1/4W, 5%	595-131
R7, 16	Resistor, 150Ω, 1/4W, 5%	595-151
R19, 72, 126	Resistor, 240Ω, 1/4W, 5%	595-241
R116	Resistor, 270Ω, 1/4W, 5%	595-271
R11, 12, 13, 65	Resistor, 511Ω, 1/4W, 5%	595-511
R30, 37, 50, 57, 81, 93, 101, 112, 120, 137	Resistor, 560Ω, 1/4W, 5%	595-561
R6	Resistor, 620Ω, 1/4W, 5%	595-621
R103	Resistor, 750Ω, 1/4W, 5%	595-751
R105	Resistor, 910Ω, 1/4W, 5%	595-911
R27	Resistor, 1K, 1/4W, 5%	595-102
R15, 17	Resistor, 1.1K, 1/4W, 5%	595-112
R20	Resistor, 1.2K, 1/4W, 5%	595-122
R5, 14, 109	Resistor, 1.5K, 1/4W, 5%	595-152
R54, 97	Resistor, 2.2K, 1/4W, 5%	595-222
R77, 131	Resistor, 2.7K, 1/4W, 5%	595-272
R4	Resistor, 3K, 1/4W, 5%	595-302
R28, 34, 35, 40, 42, 47, 55, 61, 78, 84, 86, 90, 98 104, 118, 121, 111	Resistor, 1.5K, 1/8W, 5%	594-152
R88	Resistor, 390Ω, 1/2W, 5%	596-391
R2	Resistor, 510Ω, 1/2W, 5%	596-511
R76, 130	Resistor, 560Ω, 1/2W, 5%	596-561
R3	Resistor, 1K, 1/2W, 5%	596-102
R70, 124	Resistor, 1.3K, 1/2W, 5%	596-132
R21	Resistor, 1.8K, 1/2W, 5%	596-182
R62	Resistor, 300Ω, 1W, 5%	597-301
R68, 133	Resistor, 330Ω, 1W, 5%	597-331
R140, 141, 142, 143	Resistor, 300Ω, 3W, WW	610-061
R138, 139	Resistor, 600Ω, 3W, WW	610-001
R44	Resistor, 249Ω, 1/2W, 1%	618-016
R41, 71, 74, 85, 125, 127	Resistor, 499Ω, 1/2W, 1%	618-001
R91, 48	Resistor, 2.21K, 1/4W, 1%	617-007
R73, 128	Resistor, 3.01K, 1/2W, 1%	618-018
Q22, 37	Transistor, CDQ 10239	11701
Q1, 4, 5, 40, 41	Transistor, E-H 805	11722
Q7	Transistor, 2N966	663-032
Q3, 6, 8-21, 23-36, 38, 39	Transistor, E-H 1367 (Yel.)	A11477
Q2	Transistor, E-H 1367 (Red)	A11478

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
L1	Choke, 1.5μh (Not Molded)	335-018
L2	Choke, 12T, (#28)	11404
L3	Choke, 2T, (#26)	11402
R115	Potentiometer, 50Ω	551-032
S203, 204	Switch, Rotary, 10 pos.	624-046
(7, 10, 14")	UG58A/U Coax. Cable	776-003
123	Socket Pin Assembly	495-027

5-4 OUTPUT CIRCUIT BOARD

	P. C. Board, Output	B11204
C2	Capacitor, Disc., .01mfd	312-003
C1	Capacitor, EL., .25mfd, 25v	316-028
L2, 3	Choke, 10T (old core)	11403
L1, 4	Choke	10732
CR1-2, 3-4	Diode, 1N751 (Matched Pairs)	11731
CR5-10	Diode, 1N749 (Matched Pairs)	A11734
CR14, 15	Diode, 1N914B	376-022
CR11, 12	Diode, 1N830, (Matched Pairs)	A11739
CR13	Diode, 1N830,	A11737
R52, 59	Potentiometer, 100Ω,	551-024
R24, 26, 35, 37	Resistor, 4.7Ω, 1/4w. 5%	595-047
R22, 23, 29, 30, 33, 34, 39, 40	Resistor, 24Ω, 1/4w, 5%	595-240
R27, 28	Resistor, 15Ω, 1/4w, 5%	595-150
R18, 19	Resistor, 22Ω, 1/4w, 5%	595-220
R13, 14	Resistor, 33Ω, 1/4w, 5%	595-330
R8, 9	Resistor, 47Ω, 1/4w, 5%	595-470
R1, 2, 41	Resistor, 51Ω, 1/4w, 5%	595-510
R4, 5	Resistor, 68Ω, 1/4w, 5%	595-680
R44	Resistor 330Ω, 1/4w, 5%	595-331
R43, 51, 58	Resistor, 510Ω, 1/4w, 5%	595-511
R42	Resistor, 750Ω, 1/4w, 5%	595-751
R6, 10, 11, 15, 16, 20, 21, 31, 32, 38, 49, 55, 60	Resistor, 1.5K, 1/4w, 5%	595-152
R54	Resistor, 1.6K, 1/4w, 5%	595-162
R47	Resistor, 2K, 1/4w, 5%	595-202
R50	Resistor, 2.7K, 1/4w, 5%	595-272
R48	Resistor, 82Ω, 1/2w, 5%	596-820
R3	Resistor, 620Ω, 1/2w, 5%	596-621
R53	Resistor, 1.6K, 1/2w, 5%	596-162
R46, 57	Resistor, 510Ω, 1w, 5%	597-511
R45, 56	Resistor, 50Ω, 3w, WW	610-068
R36	Resistor, 68Ω, 3w, WW	610-075
R25	Resistor, 100Ω, 3w, WW	610-060
R17	Resistor, 150Ω, 3w, WW	610-076
R7, 12	Resistor, 300Ω, 3w, WW	610-061
Q18, 19	Transistor, CDQ 10239	A11701
Q22	Transistor, 2N1132	663-024
Q17	Transistor, 2N250	A11705
Q20	Transistor, SS2105	11746
Q1-16	Transistor, E-H 1367	A11476
Q21	Transistor, SJ7748 (Special)	A11719
(9")	Special 50Ω, Coaxial Cable	776-008
	Socket Pin Assembly	495-027

5-5 POWER SUPPLY

POWER SUPPLY CHASSIS

	Terminal Board	480-006
	Jumper	484-023
	Marker Strip	484-024
	Terminal Block	484-025
	Terminal, W Type	484-027
	Cover, Terminal Block	A11401
T101	Transformer	10562
L101	Choke	10564
L102, 103	Choke	10563
C102	Capacitor, EL, 1500mfd/50V	316-045
CR101 106	Diode, 1N253	376-041
R103	Potentiometer, 100Ω, 2w	545-035
R105, 107	Potentiometer, 500Ω, 2w	545-034
R101	Resistor, 5Ω, 10w, WW,	610-033
R102	Resistor, 10Ω, 10w, WW,	610-078
R108, 111	Resistor, 1Ω, 3w, WW,	610-069
R109, 110	Resistor, 2Ω, 3w, WW,	610-077
R112	Resistor, 5.1K, 1/4w, 5%	595-512
R113	Resistor, 3K, 1/4w, 5%	595-302
Q101, 105	Transistor, E-H 026	A11705
	Transistor Socket	490-001
	Connector, 18 pin P.C.	743-008
R104	Potentiometer, 1K	545-003
C103, 104	Capacitor, 1μf, 25v	311-038
	Power Cable	C11218
C101	Capacitor, EL 3500 μf/50v	316-052

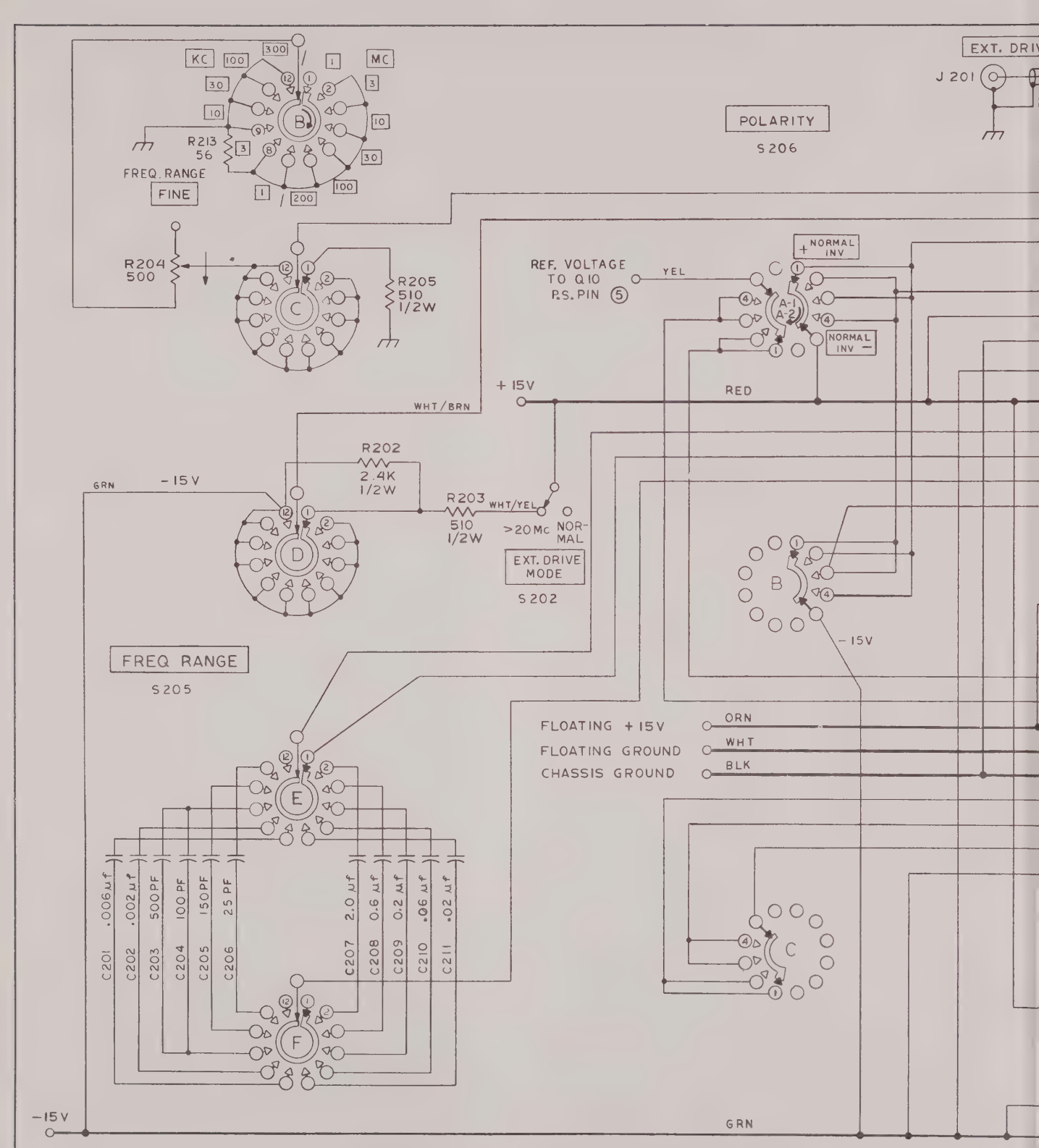
CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
REGULATOR PC BOARD		
	P. C. Board, Regulator	B11125
C1, 4	Capacitor, EL, 100 mfd/25v	316-035
C2, 3, 5, 6	Capacitor, EL, 25 mfd/25v	316-028
CR1, 5	Diode, 1N914B	376-022
CR2, 6	Diode, 1N746A	374-017
CR3	Diode, 1N3016	374-042
CR4	Diode, 1N4005	376-034
CR7	Diode, 1N751A	374-022
R1	Resistor, 3.3K, 1/2W, 5%	596-332
R2, 3, 9	Resistor, 200Ω, 1/2W, 5%	596-201
R4	Resistor, 620Ω, 1/2W, 5%	596-621
R5	Resistor, 100Ω, 1/2W, 5%	596-101
R6	Resistor, 270Ω, 1/2W, 5%	596-271
R7, 8, 20	Resistor, 1.5K, 1/2W, 5%	596-152
R23	Resistor, 330Ω, 1/2W, 5%	596-331
R10	Resistor, 820Ω, 1/2W, 5%	596-821
R11, 19	Resistor, 1K, 1/2W, 5%	596-102
R12	Resistor, 2.7K, 1/2W, 5%	596-272
R13	Resistor, 180Ω, 2W, 5%	598-181
R14	Resistor, 2K, 1/2W, 1%	618-005
R15	Resistor, 6.2K, 1/2W, 5%	596-622
R16	Resistor, 4.7K, 1/2W, 5%	596-472
R17	Resistor, 3K, 1/2W, 5%	596-302
R18	Resistor, 1.87K, 1/2W, 1%	618-017
R21	Resistor, 510Ω, 1/2W, 5%	596-511
R22	Resistor, 5.1K, 1/2W, 5%	596-512
R24	Resistor, 910Ω, 1W, 5%	597-911
Q1-6, 9	Transistor, SM7719	A11725
Q7, 8, 10	Transistor, SM7718	A11724
	Bracket	A10946

5-6 CHASSIS AND PANEL COMPONENTS

FRONT PANEL

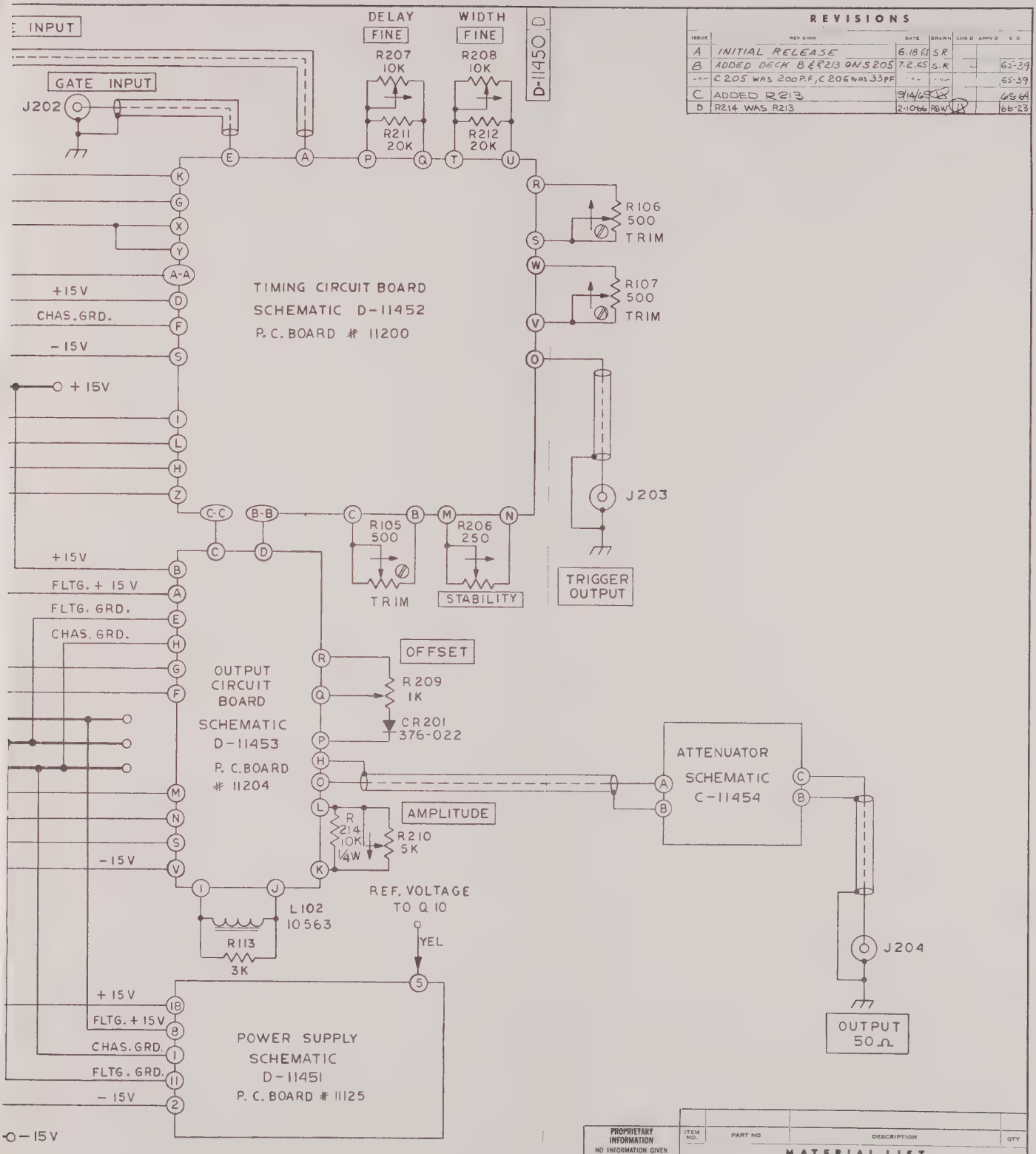
	Front Panel	C10960
DS201	Pilot Light	510-008
R204	Potentiometer, 500Ω, 2W	550-001
R206	Potentiometer, 250Ω, 2W	550-017
R207, 208	Potentiometer, 10K, 2W	550-012
R209	Potentiometer, 1K, 2W	550-002
R210	Potentiometer, 5K, 2W	550-003
R201	Resistor, 100K, 1/2W, 5%	596-104
R211, 212	Resistor, 20K, 1/4W, 5%	595-203
S201	Switch, Toggle	630-006
S202	Switch, Toggle	630-010
	Connector, GR	721-024
	Knob, Med.	443-008
	Knob, Small	443-009
R214	Resistor, 10K, 1/4W, 5%	595-103
	Attenuator Assembly	11629

CIRCUIT REFERENCE	DESCRIPTION	E-H PART NO.
POLARITY SWITCH		
S206	Switch Deck PA-O	624-001
	Switch, Deck PA-5	624-027
	Switch, Index, PA-300	624-011
CR201	Diode, 1N914B	376-022
FREQUENCY RANGE SWITCH		
S205	Switch, Index	624-029
	Switch, Deck	624-020
C201	Capacitor, Poly, 6000 pf, 500, 5%	326-007
C202	Cap., Poly, 2000 pf, 500, 5%	326-012
C203	Cap., Poly,500 pf, 500, 5%	326-003
C204	Cap., Poly, 100 pf, 500, 5%	326-002
C205	Cap., Poly, 150 pf, 500, 5%	326-010
C206	Cap., Ceramic, 25 pf, 10%	311-003
C207	Cap., Mylar, 2.0 mfd,200v, 5%	320-026
C208	Cap., Mylar, .6 mfd, 200v, 5%	320-025
C209	Cap., Mylar, .2 mfd, 200v, 5%	320-024
C210	Cap., Mylar, .06 mfd, 200v, 5%	320-023
C211	Cap., Mylar, .02 mfd, 200v, 5%	320-022
R202	Resistor, 2.4K, 1/2 W, 5%	596-242
R203, 205	Resistor, 510Ω, 1/2 W, 5%	596-511
R213	Resistor, 56 Ω, 1/4 W, 5%	595-560
REAR PANEL		
	Rear Panel	C10951
J101	A. C. Receptable	700-018
XF101	Fuse Holder	396-001
F101	Fuse, 1.5 amp., S.B.	398-010
B101	Fan Assembly	570-007
MISCELLANEOUS		
	Coupling	465-004
	Cover, Top	C10975
	Cover, Bottom	C10446
	Rubber Bumper	417-002
	Power Cord	786-001
S203, 204	Switch, Detent	624-047
	Knob, Med.	443-008
	Transistor Heat Sink	11337-01
	Frame	C10287
	Connector Board Runner	C10444



UNLESS NOTED:

1. ALL ROTARY SWITCHES ARE SHOWN AS VIEWED FROM THE FRONT.
2. ALL RESISTORS ARE IN OHMS, 1/4W, 5%
3. ⏚ INDICATES CHASSIS GROUND



REVISIONS						
ISSUE	REVISION	DATE	DRAWN	CHK'D	APPV'D	E.O.
A	INITIAL RELEASE	6.18.65	S.R.			
B	ADDED DECK B&R213 ON S205	7.2.65	S.R.			65-39
-IN-	C205 WAS 200P.F, C206 WAS 33PF	-"-	-"-			65-39
C	ADDED R213	9/14/65				65-64
D	R214 WAS R213	2-1066	RBW			66-23

ITEM NO.	PART NO	DESCRIPTION	QTY

MATERIAL LIST

PROPRIETARY INFORMATION
NO INFORMATION GIVEN HEREIN MAY BE DISSEMINATED TO ANY PERSON OR COMPANY WITHOUT THE EXPRESS PERMISSION OF E-H RESEARCH LABORATORIES, INC.

UNLESS OTHERWISE SPECIFIED
SCALE
DIMENSIONS ARE IN INCHES
DECIMALS ± XX = ± XXX =
ANGLES ±
MACHINED SURFACES √
DO NOT SCALE DRAWING
FINISH

NEXT ASS'Y
REQ'D 1
USED ON 122

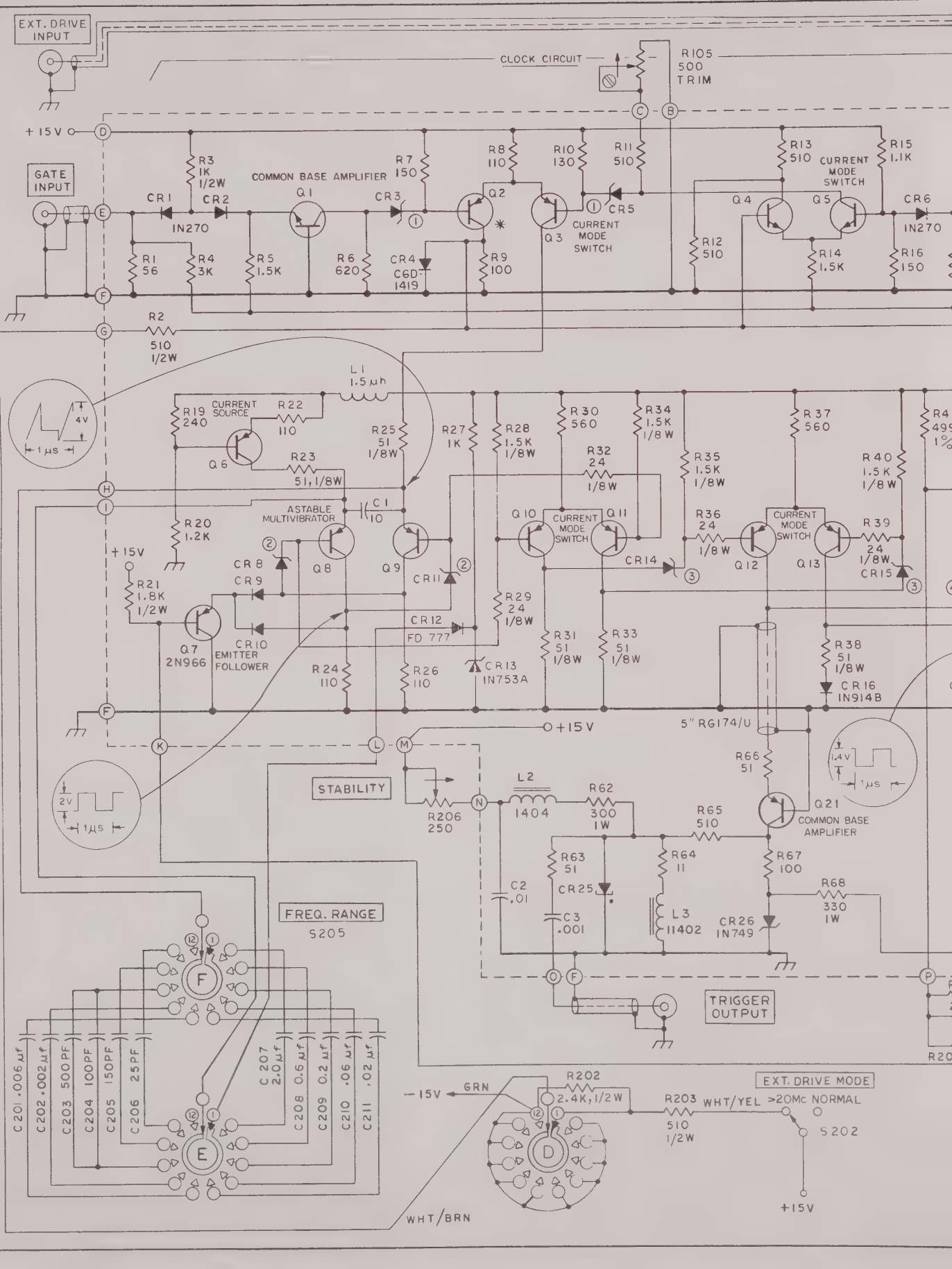
E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE
MASTER
SCHEMATIC
MODEL 122

	INITIALS	DATE
DRAWN	STEVAN	6.17.65
CHK'D	B. H.	6/23/65
APP'D	PEB	6/23/65

D-11450 | ISSUE D

SHEET NO. 1 OF 1 SHEETS


EXT. DRIVE INPUT
CLOCK CIRCUIT
R105 500 TRIM
+15V
GATE INPUT
COMMON BASE AMPLIFIER
Q1
CR1
CR2
IN270
CR3
R1 56
R2 510 1/2W
R3 1K 1/2W
R4 3K
R5 1.5K
R6 620
R7 150
CR4 C6D 1419
R8 110
Q2
R9 100
R10 130
Q3
R11 510
CR5
CURRENT MODE SWITCH
R12 510
R13 510
Q4
Q5
CURRENT MODE SWITCH
R14 1.5K
R15 1.1K
CR6
IN270
R16 150
L1 1.5 µh
R19 240
CURRENT SOURCE
R22 110
Q6
R23 51, 1/8W
R25 51 1/8W
R27 1K
R28 1.5K 1/8W
R30 560
R32 24 1/8W
R34 1.5K 1/8W
R35 1.5K 1/8W
R37 560
R40 1.5K 1/8W
4V
1 µs
ASTABLE MULTIVIBRATOR
C1 10
R20 1.2K
Q8
Q9
Q10
CURRENT MODE SWITCH
Q11
CR14
R36 24 1/8W
Q12
CURRENT MODE SWITCH
Q13
R39 24 1/8W
CR15
+15V
R21 1.8K 1/2W
CR8
CR9
Q7 2N966
CR10 EMITTER FOLLOWER
CR11
CR12 FD 777
R29 24 1/8W
R31 51 1/8W
R33 51 1/8W
R24 110
R26 110
CR13 IN753A
R38 51 1/8W
CR16 IN914B
5" RG174/U
+15V
2V
1 µs
STABILITY
R206 250
L2 1404
R62 300 1W
R65 510
R66 51
1.4V
1 µs
Q21 COMMON BASE AMPLIFIER
R63 51
R64 11
R67 100
R68 330 1W
C2 .01
CR25
C3 .001
L3 11402
CR26 IN749
TRIGGER OUTPUT
FREQ. RANGE S205
C201 .006 µf
C202 .002 µf
C203 500 PF
C204 100 PF
C205 150 PF
C206 25 PF
C207 2.0 µf
C208 0.6 µf
C209 0.2 µf
C210 .06 µf
C211 .02 µf
-15V
GRN
R202 2.4K, 1/2W
R203 510 1/2W
WHT/YEL
EXT. DRIVE MODE
>20Mc
NORMAL
S202
+15V
WHT/BRN

D-11452 F

REVISIONS						
ISSUE	REVISION	DATE	DRAWN	CHK'D	APP'D	E.O.
B	SEE SHEET 2 OF 2					
C	SEE SHEET 2 OF 2					
D	--- " ---					
E	--- " ---					

WAVE FORM CONDITIONS

REP RATE — 1 Mc
DELAY — MINIMUM
WIDTH RANGE — 100-300 ns
FINE — FULL COUNTERCLOCKWISE
PULSE MODE — POSITIVE NORMAL
AMPLITUDE — MAXIMUM
OSCILLISCOPE — TEKTRONIX TYPE 661
5T1A, 4S1 } PLUG-IN UNITS

CR7
D61419
R17 1K
R18 56

FROM Q31

-15V

DELAY CIRCUIT

WIDTH CIRCUIT

+15V

R42 1.5K 1/8W
R44 249 1% POSITIVE CURRENT SOURCE Q14
R45 51
R47 1.5K 1/8W
R48 2.2K 1%
R50 560
R54 2.2K
R55 1.5K 1/8W
R57 560
R61 1.5K 1/8W
DELAY CURRENT MODE SWITCH Q15 Q16
R43 24 1/8W
R46 24 1/8W
R49 24 1/8W
Q17 SCHMITT TRIGGER Q18
R56 24 1/8W
CURRENT MODE SWITCH Q19 Q20
R60 24 1/8W
CR17
CR20 ④
CR21 ⑤
CR23 ⑥
CR22 ⑤
CR24 ⑥
R51 36
TO CR27 ⑦
TO CR28 ⑦
R52 15
R53 51 1/8W
R58 51 1/8W
R59 51 1/8W
CHASSIS GROUND
18 FD-777 CR19
R72 240
NEGATIVE CURRENT SOURCE Q22 11701
R73 3.01K 1%
S203 DELAY
L4 11437
R76 560 1/2W
R77 2.7K
-15V
C4 .33μf
C5 .1μf
C6 .04μf
C7 .01μf
C8 .004μf
C9 .68PF
C10 330PF
C11 .001μf
R70 1.3K 1/2W
R71 499 1%
R74 499 1%
R106 500 TRIM
P.C. BOARD # 11200
NOTES ON SHEET 2 OF 2
DELAY FINE
10K
FREQ RANGE
FINE
R204 500
R205 510 1/2W
R213 56

ITEM NO	PART NO.	DESCRIPTION	QTY
MATERIAL LIST			

PROPRIETARY INFORMATION
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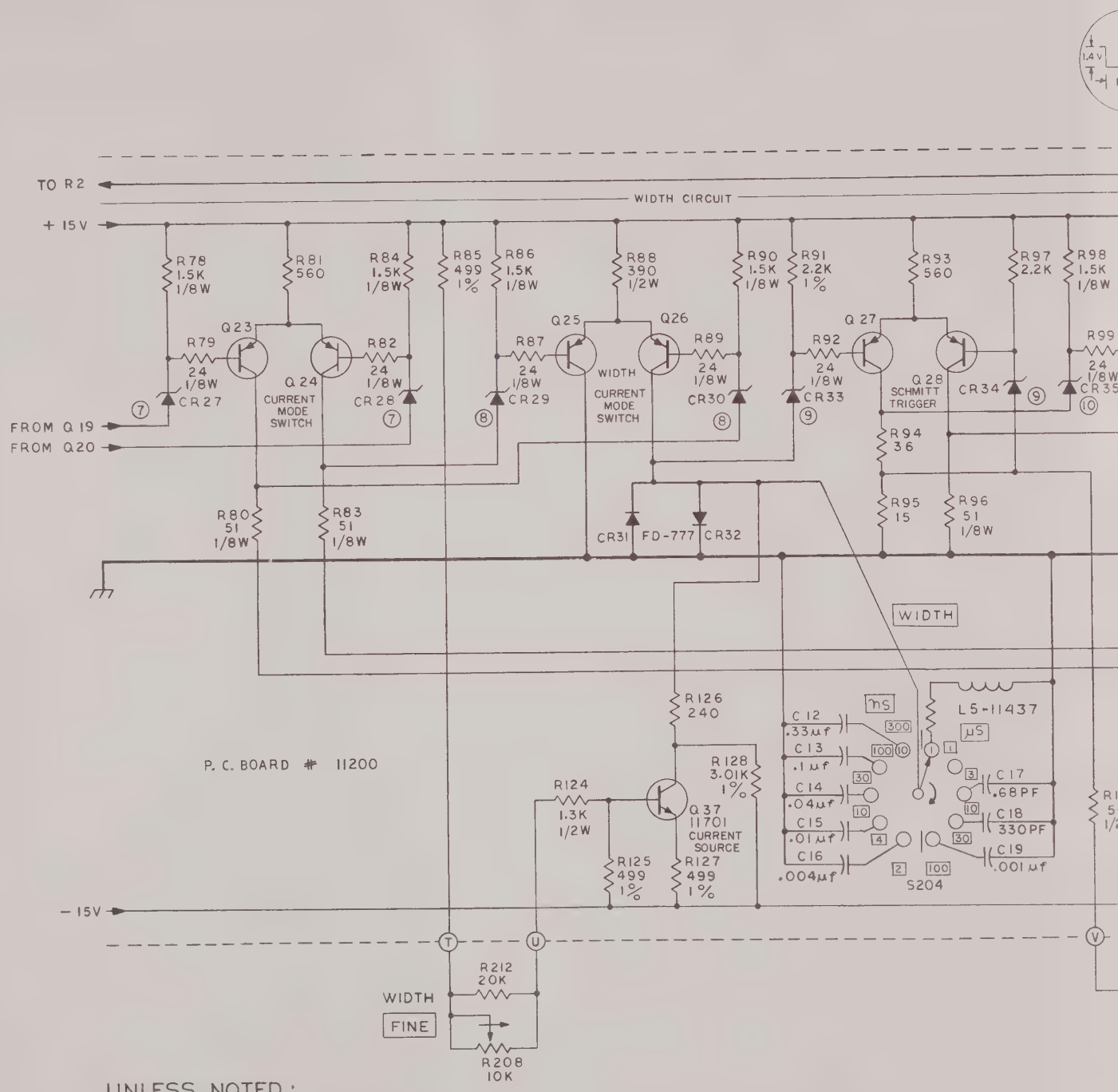
SCALE
DIMENSIONS ARE IN INCHES
DECIMALS: ± XX ; ± XXX
ANGLES ±
MACHINED SURFACES
DO NOT SCALE DRAWING
FINISH
NEXT ASSY
REQ'D
1
122
USED ON

E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE
TIMING CIRCUIT BOARD SCHEMATIC
MODEL 122

	INITIALS	DATE
DRAWN	STEVAM	6.5.65
CHK'D	B.H.	6/23/65
APP'D	DEB	6/23/65

D-11452 ISSUE E
SHEET NO 1 OF 2 SHEETS



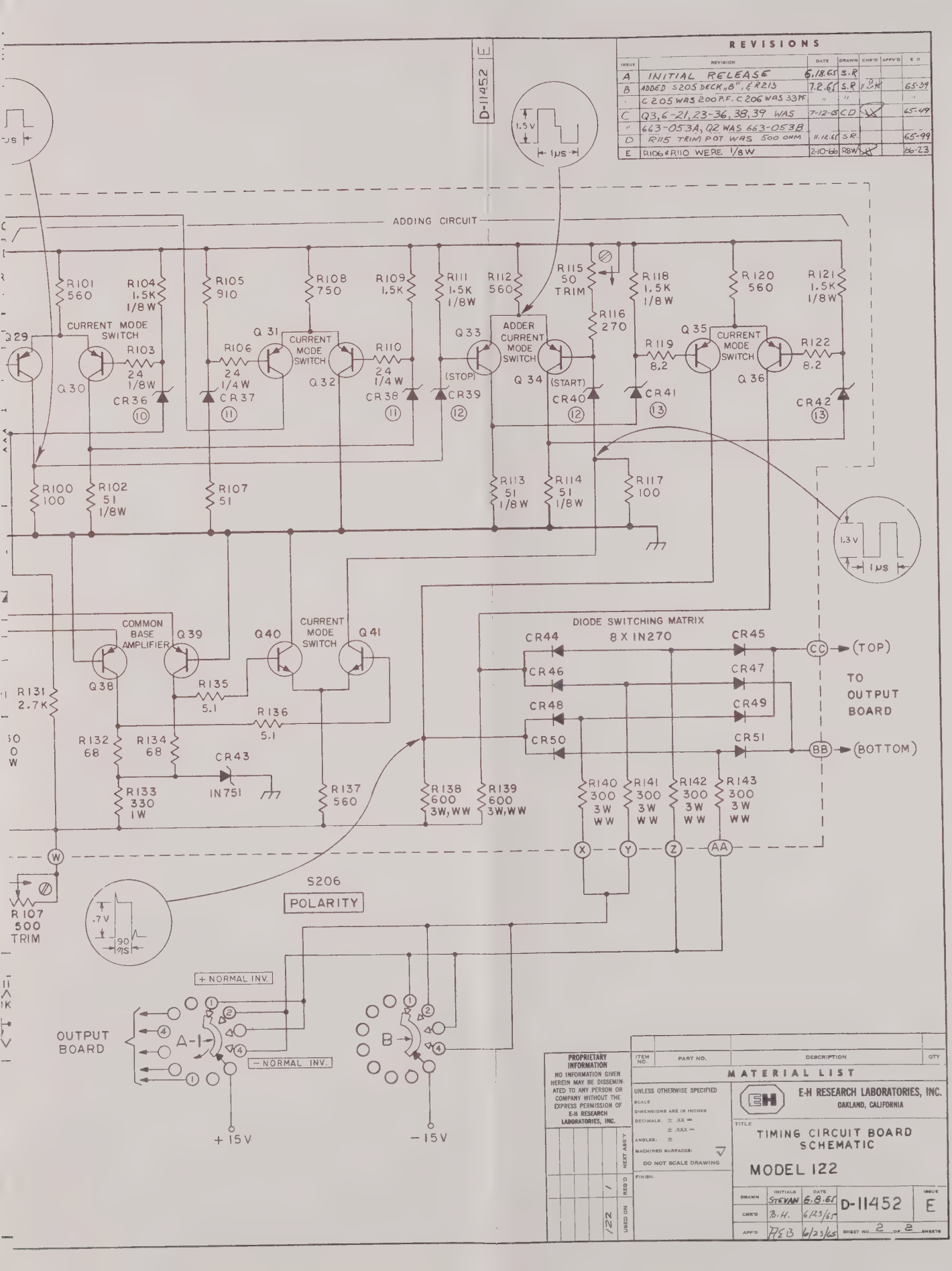
UNLESS NOTED :

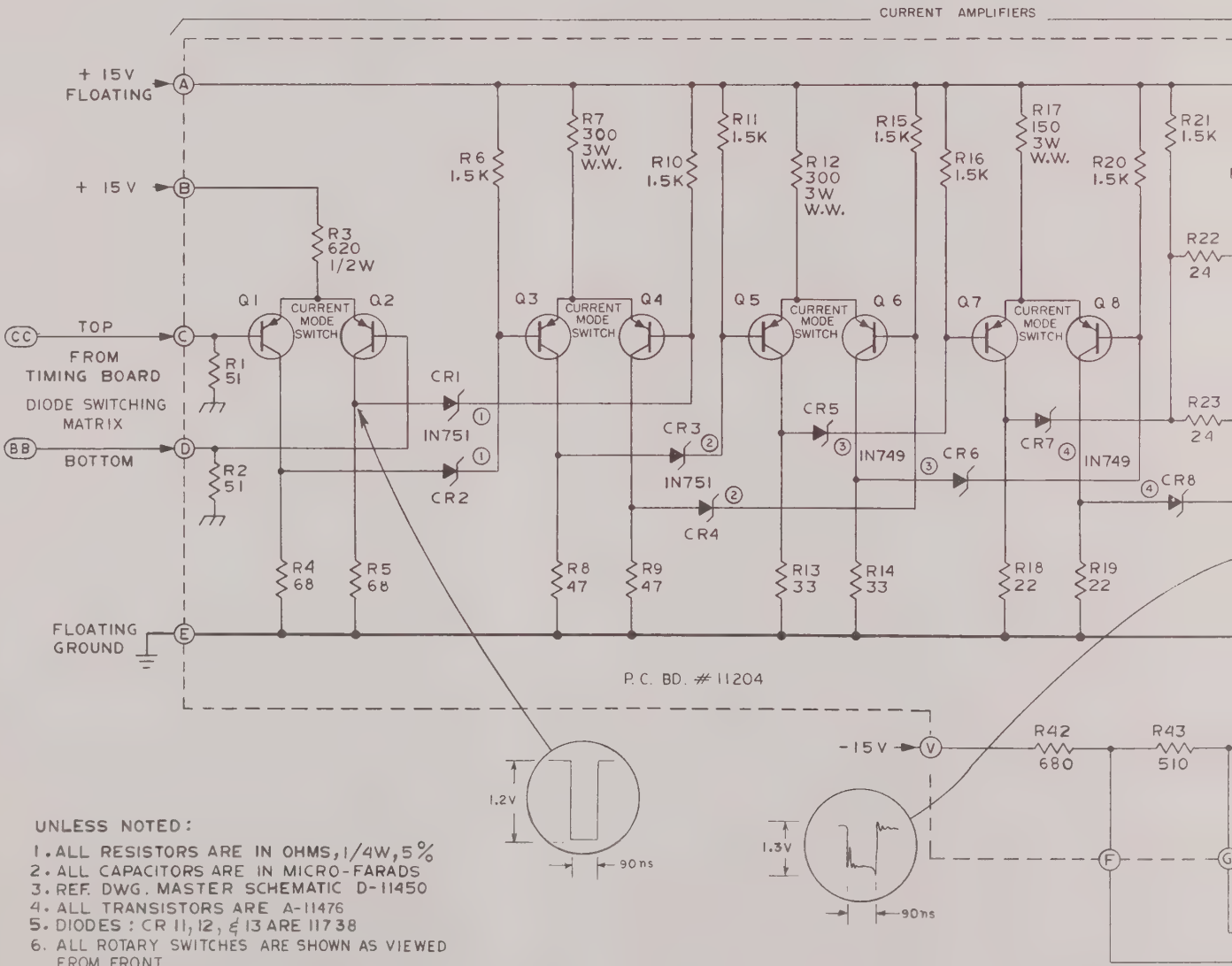
1. ALL RESISTORS ARE IN OHMS, 1/4 W, 5%
2. ① TO ⑬ ALL ZENER DIODES-MATCHED PAIR ARE IN751
3. ALL TRANSISTORS : PNP ARE A-11477
   —— // —— : NPN ARE 11722
   * Q2 PNP IS A-11478
4. REF. DRWG. MASTER SCHEMATIC D-11450
5. DIODES : CR9, CR10 (MATCHED PAIR) E-H-033B
6. — // — CR25 (TUNNEL DIODE) E-H-060
7. ROTARY SWITCHES ARE SHOWN AS VIEWED FROM FRONT
8. ⏚ INDICATES CHASSIS GROUND

NOT USED

R	69, 123, 75, 129

R	C	CR	Q	L
143	19	51	41	5

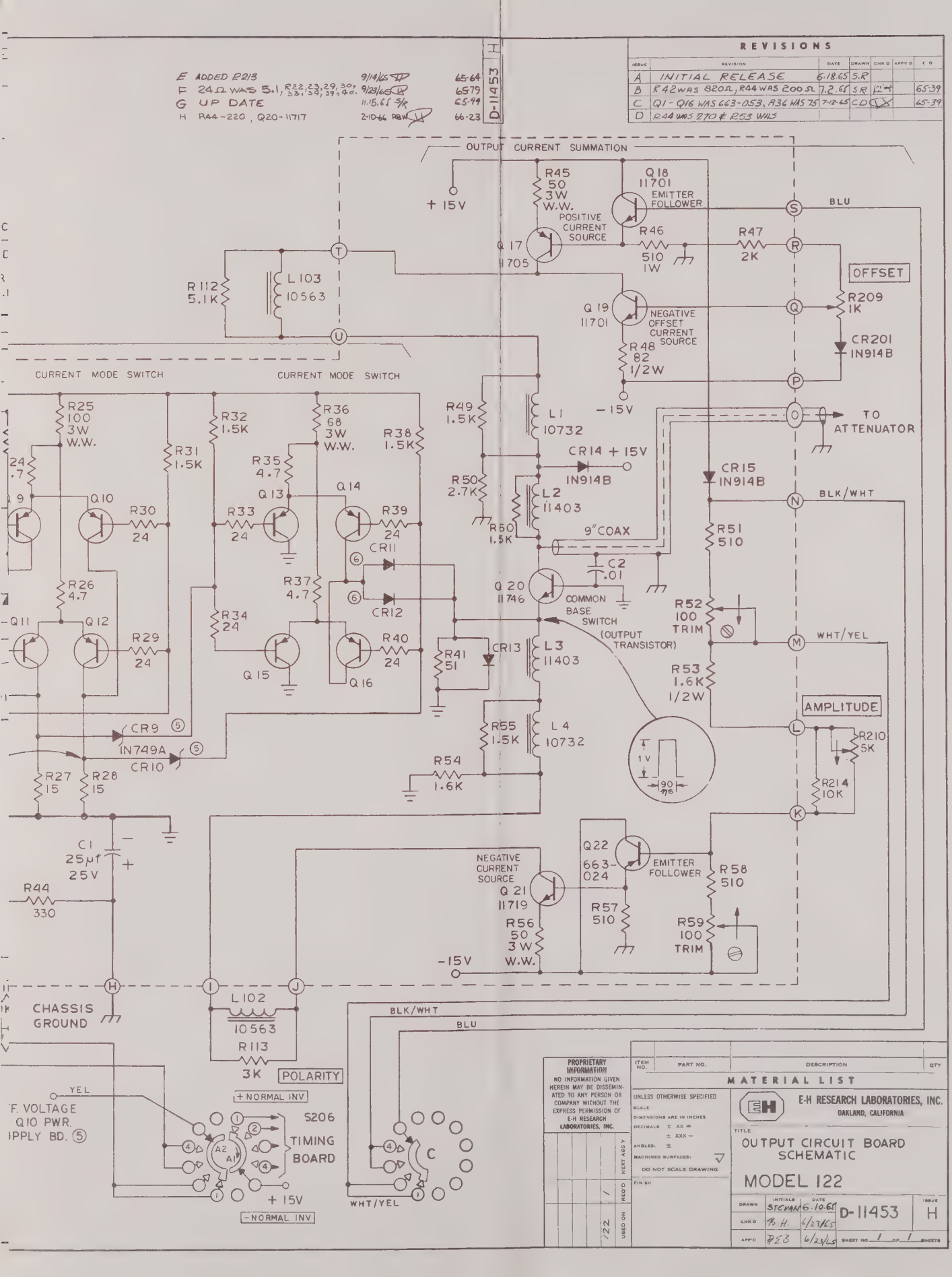

REVISIONS
ISSUE | REVISION | DATE | DRAWN | CHK'D | APPV'D | E O
A | INITIAL RELEASE | 6.18.65 | S.R
B | ADDED S205 DECK „B", & R213 | 7.2.65 | S.R | B.H | 65-39
" | C 205 WAS 200 P.F. C 206 WAS 33 PF | " | " | " | " | "
C | Q3,6-21,23-36,38,39 WAS | 7-12-65 | CD | | 65-49
" | 663-053A, Q2 WAS 663-053B
D | R115 TRIM POT WAS 500 OHM | 11.12.65 | S.R | | 65-99
E | R106 & R110 WERE 1/8W | 2-10-66 | RBW | | 66-23
D-11452 E
ADDING CIRCUIT
R101 560
R104 1.5K 1/8W
R105 910
R108 750
R109 1.5K
R111 1.5K 1/8W
R112 560
R115 50 TRIM
R116 270
R118 1.5K 1/8W
R120 560
R121 1.5K 1/8W
CURRENT MODE SWITCH
Q29
Q30
R103 24 1/8W
CR36 (10)
Q31
CURRENT MODE SWITCH
Q32
R106 24 1/4W
CR37 (11)
R110 24 1/4W
CR38 (11)
Q33
ADDER CURRENT MODE SWITCH
Q34
(STOP)
CR39 (12)
(START)
CR40 (12)
R119 8.2
Q35
CURRENT MODE SWITCH
Q36
R122 8.2
CR41 (13)
CR42 (13)
1.5 V
1 μs
R100 100
R102 51 1/8W
R107 51
R113 51 1/8W
R114 51 1/8W
R117 100
1.3 V
1 μs
COMMON BASE AMPLIFIER
Q38
Q39
Q40
CURRENT MODE SWITCH
Q41
R131 2.7K
R135 5.1
R136 5.1
R132 68
R134 68
CR43 IN751
R133 330 1W
R137 560
R138 600 3W, WW
R139 600 3W, WW
DIODE SWITCHING MATRIX
8 X IN270
CR44
CR45
CR46
CR47
CR48
CR49
CR50
CR51
CC
(TOP)
TO OUTPUT BOARD
BB
(BOTTOM)
R140 300 3W WW
R141 300 3W WW
R142 300 3W WW
R143 300 3W WW
W
X
Y
Z
AA
R107 500 TRIM
.7 V
90 m/s
S206
POLARITY
+ NORMAL INV.
OUTPUT BOARD
A-1
B
- NORMAL INV.
+15 V
-15 V
PROPRIETARY INFORMATION
NO INFORMATION GIVEN HEREIN MAY BE DISSEMINATED TO ANY PERSON OR COMPANY WITHOUT THE EXPRESS PERMISSION OF E-H RESEARCH LABORATORIES, INC.
ITEM NO. | PART NO. | DESCRIPTION | QTY
MATERIAL LIST
UNLESS OTHERWISE SPECIFIED
SCALE
DIMENSIONS ARE IN INCHES
DECIMALS. ± .XX = ± .XXX =
ANGLES: ±
MACHINED SURFACES:
DO NOT SCALE DRAWING
FINISH
NEXT ASSY
REQ'D
USED ON
/22
E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA
TITLE
TIMING CIRCUIT BOARD SCHEMATIC
MODEL 122
DRAWN | INITIALS STEVAN | DATE 6.8.65 | D-11452 | ISSUE E
CHK'D | B.H. | 6/23/65
APP'D | 6/23/65 | SHEET NO. 2 OF 2 SHEETS



UNLESS NOTED:

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%
2. ALL CAPACITORS ARE IN MICRO-FARADS
3. REF. DWG. MASTER SCHEMATIC D-11450
4. ALL TRANSISTORS ARE A-11476
5. DIODES: CR 11, 12, & 13 ARE 11738
6. ALL ROTARY SWITCHES ARE SHOWN AS VIEWED FROM FRONT.
7. ⏚ INDICATES FLOATING GROUND
8. ⏚ INDICATES CHASSIS GROUND

R	C	CR	Q	L
60	2	15	22	4


REVISIONS
ISSUE | REVISION | DATE | DRAWN | CHK'D | APPV'D | E.O.
A | INITIAL RELEASE | 6.18.65 | S.R.
B | R42 WAS 820Ω, R44 WAS 200Ω | 7.2.65 | S.R. | 65-39
C | Q1 - Q16 WAS 663-053, R36 WAS 75 | 7-12-65 | C.D. | 65-39
D | R44 WAS 270 & R53 WAS
E ADDED R213 9/14/65 65-64
F 24Ω WAS 5.1, R22,23,29,30, 33,34,39,40. 9/23/65 6579
G UP DATE 11.15.65 65-99
H R44-220, Q20-11717 2-10-66 66-23
D-11453 H
OUTPUT CURRENT SUMMATION
+15V
R45 50 3W W.W.
POSITIVE CURRENT SOURCE
Q17 11705
Q18 11701 EMITTER FOLLOWER
R46 510 1W
R47 2K
BLU
OFFSET
R209 1K
CR201 IN914B
Q19 11701
NEGATIVE OFFSET CURRENT SOURCE
R48 82 1/2W
-15V
R112 5.1K
L103 10563
CURRENT MODE SWITCH
CURRENT MODE SWITCH
R25 100 3W W.W.
R31 1.5K
R32 1.5K
R36 68 3W W.W.
R38 1.5K
R35 4.7
Q13
Q14
R33 24
R39 24
CR11
CR12
R37 4.7
R34 24
R40 24
Q15
Q16
R26 4.7
Q11
Q12
R29 24
CR9 IN749A
CR10
R27 15
R28 15
R30 24
Q10
R49 1.5K
L1 10732
CR14 +15V IN914B
R50 2.7K
L2 11403
R60 1.5K
9" COAX
C2 .01
Q20 11746
COMMON BASE SWITCH (OUTPUT TRANSISTOR)
R41 51
CR13
L3 11403
R55 1.5K
L4 10732
R54 1.6K
1V
90 ns
TO ATTENUATOR
CR15 IN914B
BLK/WHT
R51 510
R52 100 TRIM
WHT/YEL
R53 1.6K 1/2W
AMPLITUDE
R210 5K
R214 10K
C1 25μf 25V
R44 330
NEGATIVE CURRENT SOURCE
Q21 11719
Q22 663-024
EMITTER FOLLOWER
R58 510
R57 510
R56 50 3W W.W.
R59 100 TRIM
-15V
CHASSIS GROUND
L102 10563
R113 3K
POLARITY
+NORMAL INV
-NORMAL INV
S206 TIMING BOARD
YEL
F. VOLTAGE Q10 PWR. IPPLY BD. ⑤
+15V
BLK/WHT
BLU
WHT/YEL
PROPRIETARY INFORMATION
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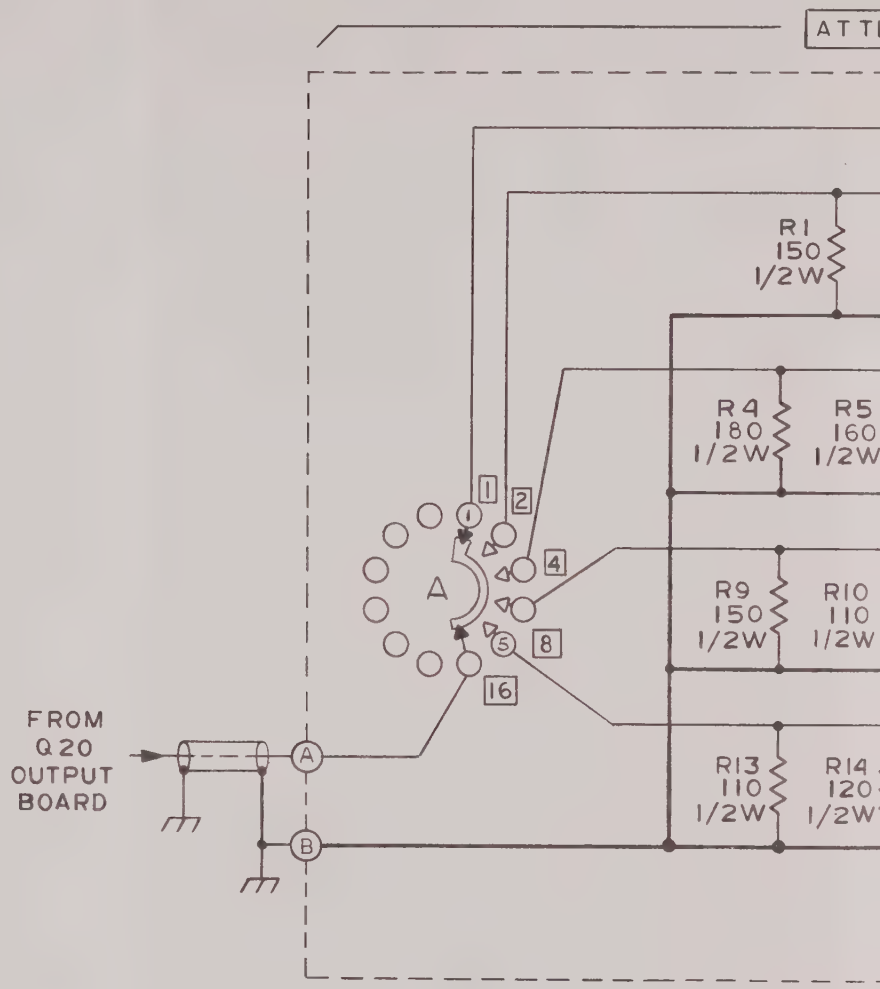
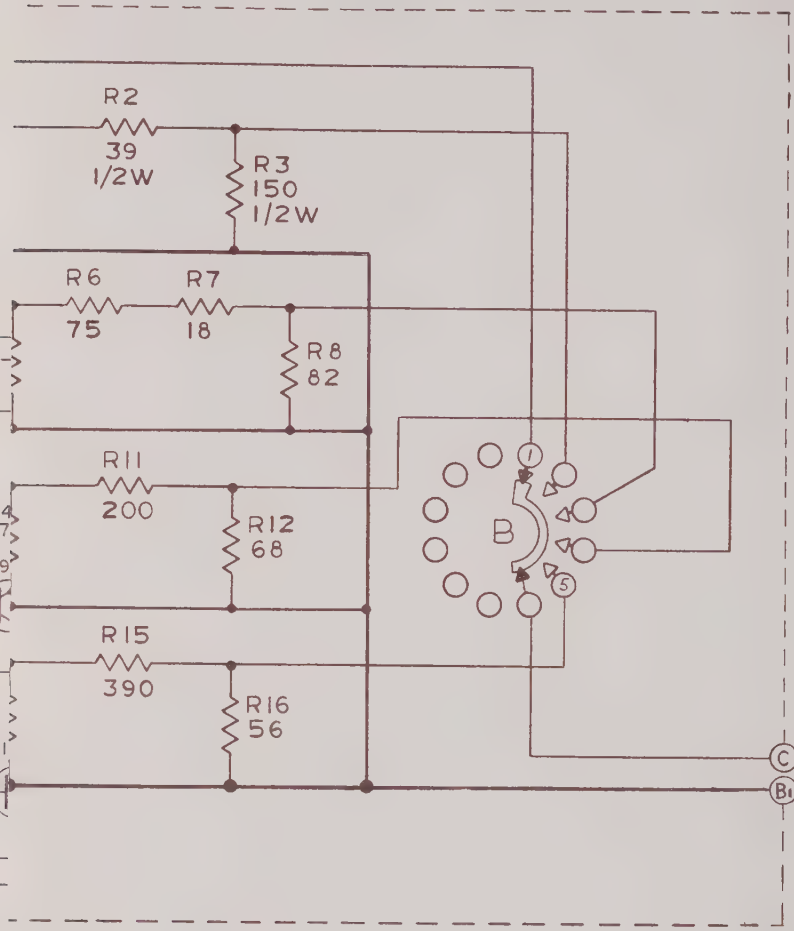
ITEM NO. | PART NO. | DESCRIPTION | QTY
MATERIAL LIST
UNLESS OTHERWISE SPECIFIED
SCALE
DIMENSIONS ARE IN INCHES
DECIMALS ± XX = ± XXX =
ANGLES: ±
MACHINED SURFACES:
DO NOT SCALE DRAWING
FINISH
NEXT ASS'Y
USED ON 122
REQ'D 1
E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA
TITLE
OUTPUT CIRCUIT BOARD SCHEMATIC
MODEL 122
DRAWN STEVAAN 6.10.65
CHK'D 6/27/65
APP'D 6/23/65
D-11453
ISSUE H
SHEET NO 1 OF 1 SHEETS



UNLESS NOTED:

1. ALL RESISTORS ARE IN OHMS, 1/4W, 5%
2. REF. DWG., MASTER SCHEMATIC D-11450
3. ⏚ INDICATE CHASSIS GROUND

NUATOR



REVISIONS

ISSUE	REVISION	DATE	DRAWN	CHK'D	APPV'D	E.O.
A	INITIAL RELEASE	6.18.65	S.R.			

C-11454 | A

ITEM NO.	PART NO.	DESCRIPTION	QTY

MATERIAL LIST

PROPRIETARY INFORMATION

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SCALE
DIMENSIONS ARE IN INCHES
DECIMALS: ± .XX = ± .XXX =
ANGLES: ±
MACHINED SURFACES: √
DO NOT SCALE DRAWING
FINISH

NEXT ASSY	REQ'D	USED ON
	1	122

E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE:

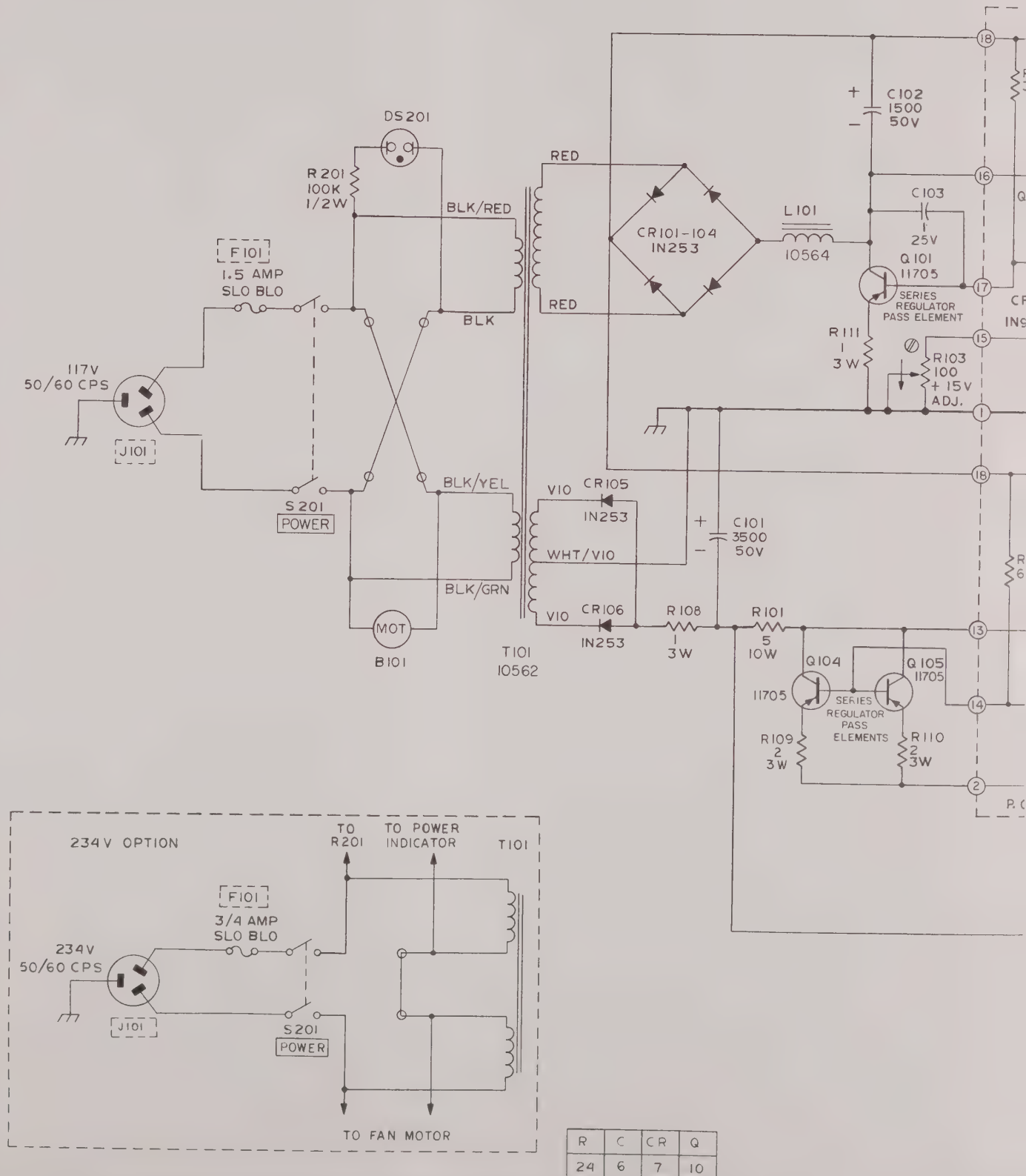
ATTENUATOR

MODEL 122

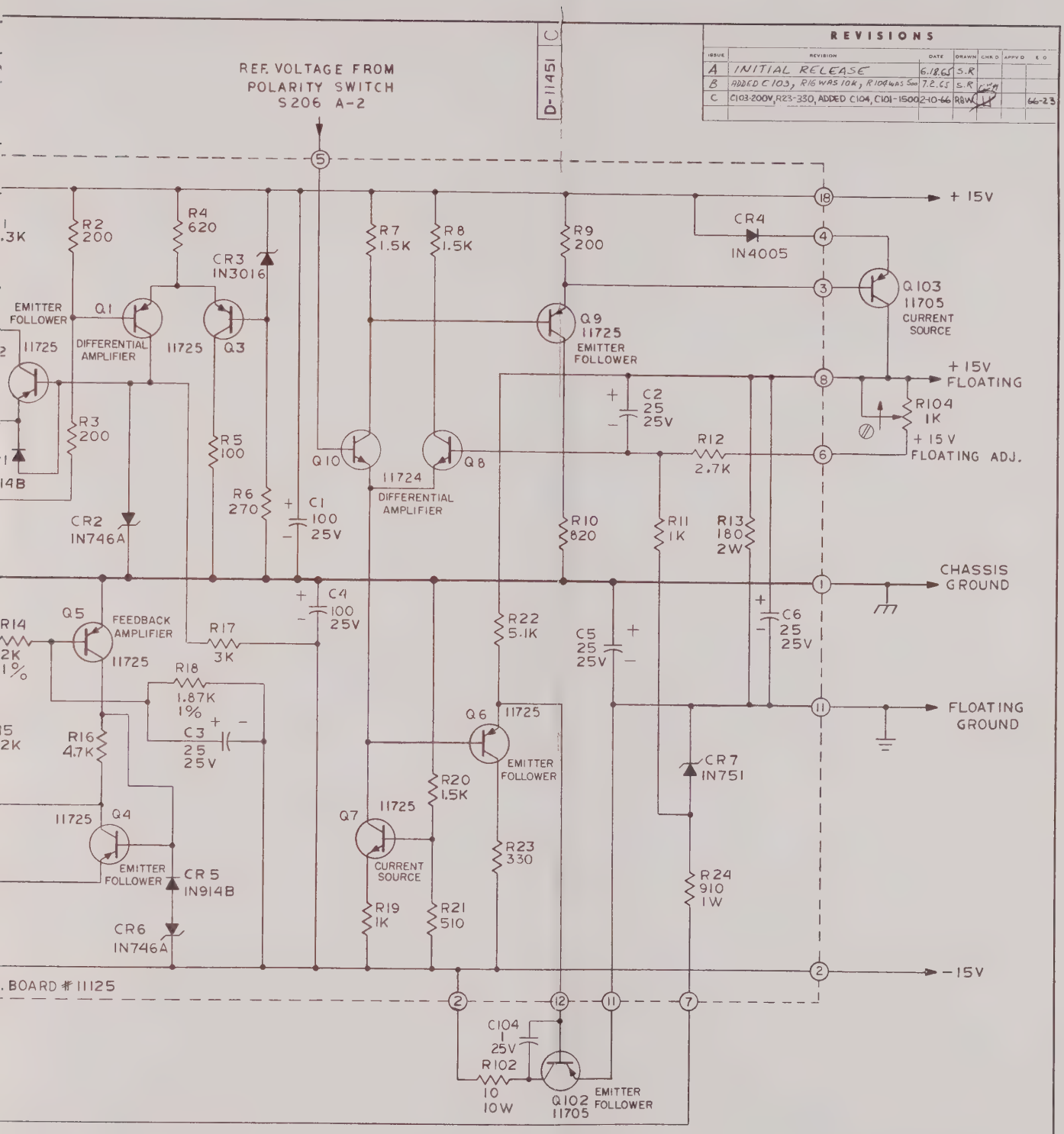
	INITIALS	DATE
DRAWN	STEVAM	6.21.65
CHK'D	B.H.	6/21/65
APP'D	REB	6/22/65

C-11454 | ISSUE A

SHEET NO 1 OF 1 SHEETS



R	C	CR	Q
24	6	7	10



UNLESS NOTED:

1. ALL RESISTORS ARE IN OHMS, 1/2W, 5%
2. ALL CAPACITORS ARE IN MICRO FARADS
3. REF. DWG. MASTER SCHEMATIC D-11450
4. ⏚ INDICATE FLOATING GROUND
5. ⏚ INDICATE CHASSIS GROUND

PROPRIETARY INFORMATION
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ITEM NO. | PART NO. | DESCRIPTION | QTY

MATERIAL LIST

UNLESS OTHERWISE SPECIFIED
SCALE
DIMENSIONS ARE IN INCHES
DECIMALS: ± .XX = ± .XXX =
ANGLES: ±
MACHINED SURFACES:
DO NOT SCALE DRAWING
FINISH

NEXT ASSY | REQ'D | USED ON
122 | 1

E-H RESEARCH LABORATORIES, INC.
OAKLAND, CALIFORNIA

TITLE:
POWER SUPPLY SCHEMATIC
MODEL 122

| | INITIALS | DATE | | ISSUE
DRAWN | STEVAN | 6.15.65 | D-11451 | C
CHK'D | R.H. | 6/23/65
APP'D | R.E.B. | 6/23/65 | SHEET NO. 1 OF 1 SHEETS

SUMMARY... PULSE GENERATORS

v=volts
a=amperes
Ω=ohms (omega)

Time abbreviations:
ps=picoseconds
ns=nanoseconds
μs=micro seconds
ms=milliseconds

MODEL	FEATURE	CLOCK	AMPLITUDE	RISETIME	WIDTH	DELAY	DUTY FACTOR	PRICE
120D	fast clean waveform at high rep rates	100 cps to 20 Mc	dual pulses −7 to −20v	<1.0ns at 10v <1.3ns at 20v	10 ns to 100 ns	fixed 100 ns	15% max	$1375
120E	same as Mod 120D, with attenuator	100 cps to 20 Mc	dual pulses −70mv to −20v	<1.3ns at 10v <1.5ns at 20v	10 ns to 100 ns	fixed 100 ns	10% max	$1675
121	1a into 50Ω at 5 ns	10 cps to 10 Mc	±5v to 50v	<5.0ns at 50v	30 ns to 1 μs	fixed 120 ns	20% max	$1675
122	rep rates to 200 Mc tr <1.0 ns	1 kc to 200 Mc	±150mv to 5v	<1.0ns at 5v	2 ns to 100 μs	2 ns to 100 μs	>40%	$2875
123A	1a into 50Ω at 50% duty factor	1 kc to 20 Mc	±200mv to 50v	<7.0 ns	20 ns to 300 μs	50 ns to 100 μs	>50%	$1775
125	clean 200 ps rise-time at 1 Mc	10 cps to 1 Mc	−10v fixed	<200 ps	<1 ns to 100 μs	100 ns to 100 μs	10% max	$2275
126	clean 400 ps edge, to 100v	40 cps to 300 cps	0v to ±100v	<400 ps	2/20/70/90ns internal lines	none	not applicable	$ 370
130	double pulse output	10 cps to 2 Mc	500 ma or 50v	10 ns	150 ns	150 ns to 50 ms	50% max	$1175
131	1a into 50Ω at low cost	10 cps to 100 kc	±100mv to 50v	<10 ns	100 ns to 500 μs	−1 μs to 1 ms	10% at 50v 20% at 25v	$ 575
132A	1a into 50Ω at 3.5 Mc	5 cps to 3.5 Mc	±400mv to 50v	<12ns to 100 ns	100 ns to 10 ms	100 ns to 10 ms	25% at 50v 50% at 25v	$ 715
133A	1a into 50Ω variable linear ramp	1 kc to 5 Mc	±200mv to 50v	<10 ns to 10 μs	50 ns to 300 μs	75 ns to 100 μs	>50%	$2275
138	dual outputs both polarities	300 cps to 10 Mc	±75mv to 7.5v	<10 ns	50 ns to 1 ms	50 ns to 1 ms	>50%	$ 890
139B	versatile 10v ramp at 50 Mc rates	10 cps 50 Mc	±30mv to 10v	6 ns to 3 ms	10 ns to 10 ms	10 ns to 10 ms	>50%	$1275
171	digital xtal timing remote programming	100 cps to 5 Mc	±30mv to 10v	6 ns to 100 μs	100 ns to 9.98 ms	none	no restriction	$2875
1030	frame & p.s. for 3 ea. 1033 plug-ins	none, requires external clock	±20v to 50v	10 ns to 10 μs	dependent on external timing	dependent on external timing	>50%	$1150
1033	2 independent 1a outputs variable linear ramp							$2575
1121	50v at 2 ns, ±5v offset remote programming	none	±500mv to 50v	<2.0ns at 50v	1 μs max	dependent on external timing	10% max	$2925
5112	high voltage pulse amplifier	none	−100v to −400v	<12ns at 100v <25ns at 400v	dependent on external timing	dependent on external timing	0.3% max	$2695

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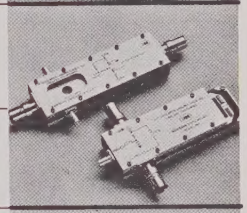
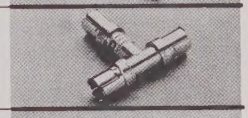
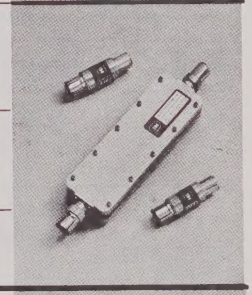
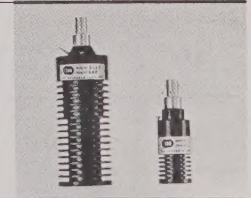
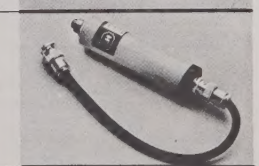
Prices and Technical Data subject to change without notice.

PULSE ACCESSORIES

	MODEL	FUNCTION	DESCRIPTION	PRICE	
GR SERIES	901	MARKER GENERATOR	A passive circuit designed to provide 1 ns markers for time-base calibration. 1% accuracy, requires fast pulse to activate. GR connectors.	$220	
	902	TUNNEL DIODE PULSER	Produces 450 mv pulse at less than 100 ps rise time from slower pulse or sine waveforms applied to input. —1 volt required to switch tunnel diode. BNC input, GR output.	$190	
	950	TRANSISTOR MOUNT	A 50 ohm transmission line mount for measurement of transistor switching times to the sub-nanosecond region. AC coupled output. BNC DC inputs, GR signal in and out.	$340	
	951	DIODE MOUNT	A 50 ohm transmission line mount for measurement of diode switching times to the sub-nanosecond region. BNC bias input, GR signal in and out.	$340	
	960	TAP-OFF	A 50 ohm transmission line sampling device. 100:1 pickoff ratio. No appreciable discontinuity introduced into 50 ohm systems to 3 Gc. GR connectors.	$90	
	970	DC RESTORER	Clamps baseline to ground to eliminate shift in AC coupled sub-nanosecond pulse systems. Peak input 20 volts. Approx. 10% attenuation. Specify pos. or neg. polarity-GR connectors.	$90	
	971	RISE TIME STANDARD	Produces fixed, repeatable rise times from fast pulse inputs. Made in std times of 5, 2, 1, 0.5, 0.2 nanosecond, ±10%. Printed circuit stability. GR connectors.	$170	
	972	PULSE TRANSFORMER	A fast inverting transformer for 50 ohm systems. Rise time better than 0.25 ns. GR connectors.	$90	
BNC SERIES	ZT	PULSE TRANSFORMER	Nanosecond transformers for impedance matching or inversion. Impedances 50, 93, 125, 185, 200 ohms. Any combination input to output with or without inversion. BNC connectors.	$35	
	DT	DC RESTORER	Clamp designed to eliminate baseline shift in AC-coupled nanosecond pulse systems. Peak input 20 volts. Approximately 10% attenuation. DTP for positive pulses, DTN for negative. BNC connectors.	$60	
	RT	RISE TIME INTEGRATOR	For repeatable, fixed, known times from fast pulse input. Standard models at 5, 10, 20, 50, 100 ns. Special times on request. 10% accuracy, 0.5 amp max. average. BNC connectors.	$35	
	ZL-3 ZL-15	TERMINATIONS	Three watt and fifteen watt terminations for 50 ohm pulse systems. DC resistance accurate to 1%. VSWR <1.25 at 100 Mc. Scope tap. BNC connectors.	$55 $75	
	TP-2 TP-5 TP-10	ATTENUATORS	High power fixed attenuators with 2:1, 5:1, 10:1 ratios. Division ratios accurate to 10%. 12 watts max. continuous dissipation. For 50 ohm input and output. VSWR <1.25 at 100 Mc. BNC connectors.	$95	
	SP-10	SINGLE PULSE TRIGGER	A battery-operated triggering device for single-pulsing all E-H pulsers. Supplies a fast-rise 10 volt spike of either polarity. With cable. BNC connectors.	$45	
	CX-5	CABLE SET	Two five-foot lengths of RG58A/U, 50 ohm cable with male BNC connectors.	$18	

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